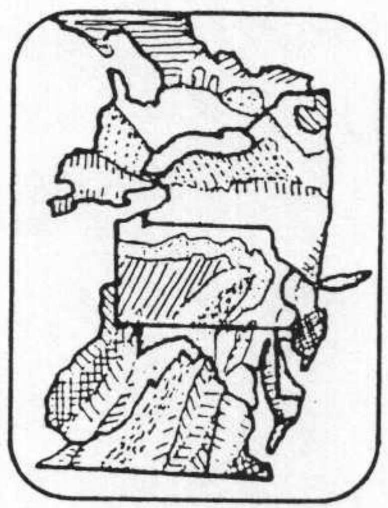
N A G T
EASTERN SECTION



GUIDE TO FIELD TRIPS
MAY 24, 1986
FROSTBURG, MD.

N A G T
EASTERN SECTION

GUIDE TO FIELD TRIPS
MAY 24, 1986
FROSTBURG, MD.

Meeting Director: Loretta L. Molitor
Physics Department
Towson State University
Towson, Maryland 21204

TABLE OF CONTENTS

COAL GEOLOGY AND LAND RECLAMATION OF THE GEORGES CREEK REGION, MARYLAND

Thomas W. Small
Frostburg State College
Frostburg, MD 21532

The bedrock geology of the western portion of Allegany County and the eastern portion of Garrett County in Maryland covered on this field trip lies near the eastern edge of the Appalachian Plateau physiographic province. The strata of the plateau in Maryland have been gently warped into a series of roughly parallel folds with southwest/northeast trending axis that follows the general structural grain of the Appalachians. Coal-bearing strata have been preserved in the synclines, whereas erosion of the intervening anticlines has stripped away the coal measures and much of the underlying Mississippian strata to the point that sizeable exposures of Devonian rocks occur.

The eastern edge of the plateau, the Allegheny Front, is a prominent southwest to northeast - trending escarpment known locally as Dans Mountain to the south of Routes 40-48 and Piney Mountain/Little Allegheny Mountain to the north of this important east-west route. The topographic prominence of the Allegheny Front can be largely attributed to the presence of Pottsville sandstones (e.g., the Sharon) that serve as a protective cap in this area. A second factor contributing to the prominence of the Allegheny Front is that the east-facing scarp is composed of the upturned edges of strata comprising the eastern limb of a syncline beyond and immediately to the west of the Front. Relief along the east-facing side of the Front ranges from 570 m (1900') near Keyser WV, to greater than 660 m (2200') at Dans Rock and to 450 m (1500') near Ellerslie at the Maryland/Pennsylvania boundary. By contrast, relief on the western slope of the Front toward the Georges Creek Basin ranges from 450 m (1500') near Franklin to 390 m (1300') at Midland and Mount Savage, respectively. (Fig. 1)

The Georges Creek Basin is the easternmost portion of the Maryland coal-fields. This basin lies in a portion of a long, narrow syncline that extends from West Virginia through Maryland and northeasterly into Pennsylvania. (Fig. 2). Technically, the structure is an outlier of the Northern Appalachian bituminous coal fields (Fig. 3). The West Virginia and southern Garrett County, Maryland portion of this structure is called the Upper Potomac Syncline. North of Westernport in Maryland it is called the Georges Creek Syncline and in Somerset and Bedford counties in Pennsylvania the northern tip of the structure is referred to as the Wellersburg Syncline. The axis of the syncline trends from N. 28^0 to 30^0 E. (Clark, 1905, p. 262). In the Georges Creek Basin, the axis lies just to the west of Westernport and extends north-eastly toward the east side of Frostburg and thence to Mount Savage (Berryhill, et. al. 1956.)

Dips of strata in the Georges Creek Syncline vary with distance from the

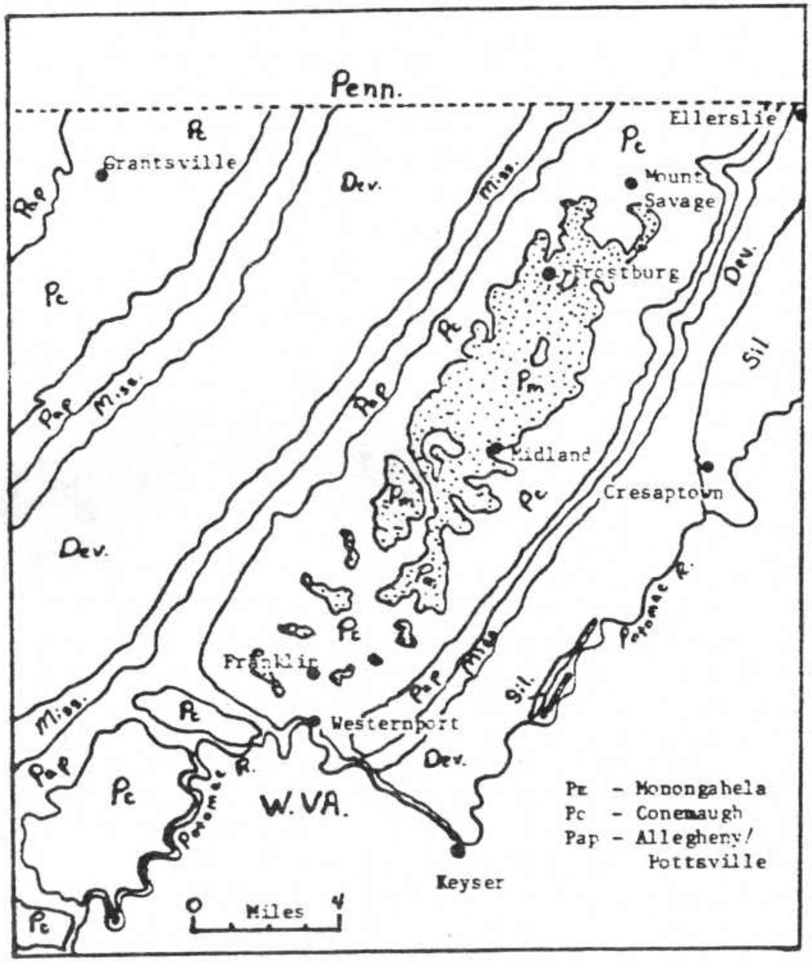


Figure 1. General locations in the field trip area. Map generalized from state geologic map, 1:250,000 scale.

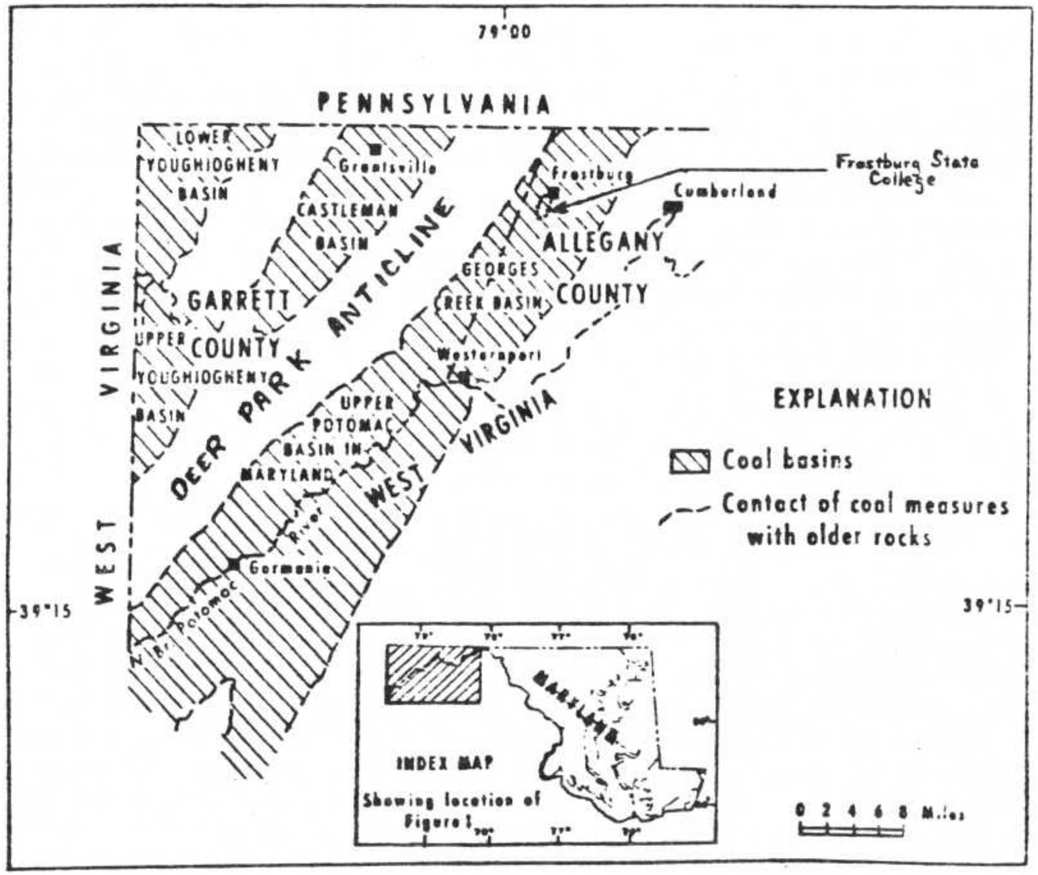


Figure 2. Map of the coal basins in the State of Maryland.

Source: Hollyday, E. F. and S. W. McKenzie, 1973, Hydrogeology of the Formation and Neutralization of Acid Waters Draining From Underground Coal Mines of Western Maryland. Maryland Geol. Surv., Report of Investig. No. 20, p. 8.

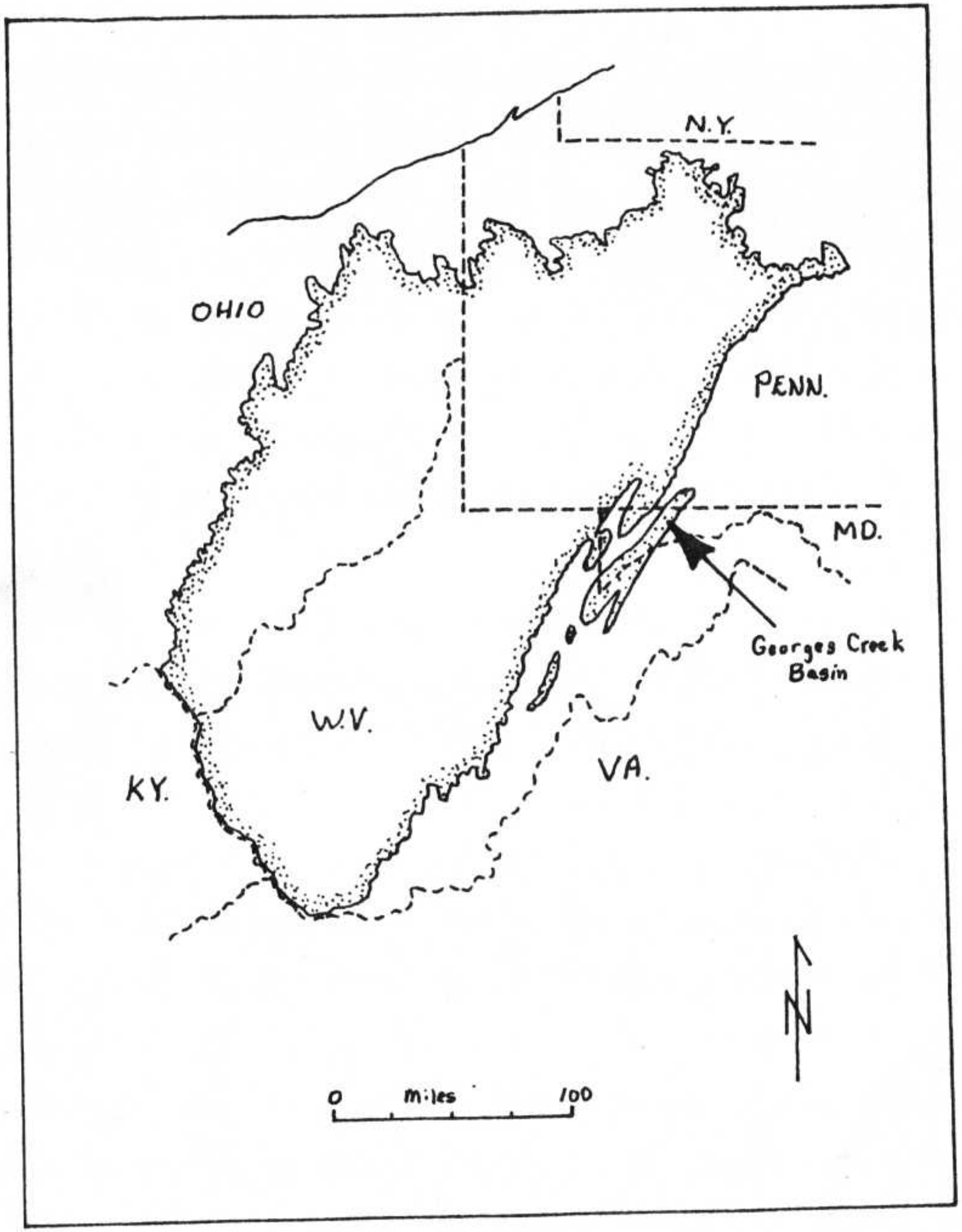


Figure 3. Georges Creek Basin location relative to the Northern Appalachian Basin. Source base map: Gas Research Institute, p. 3-44.

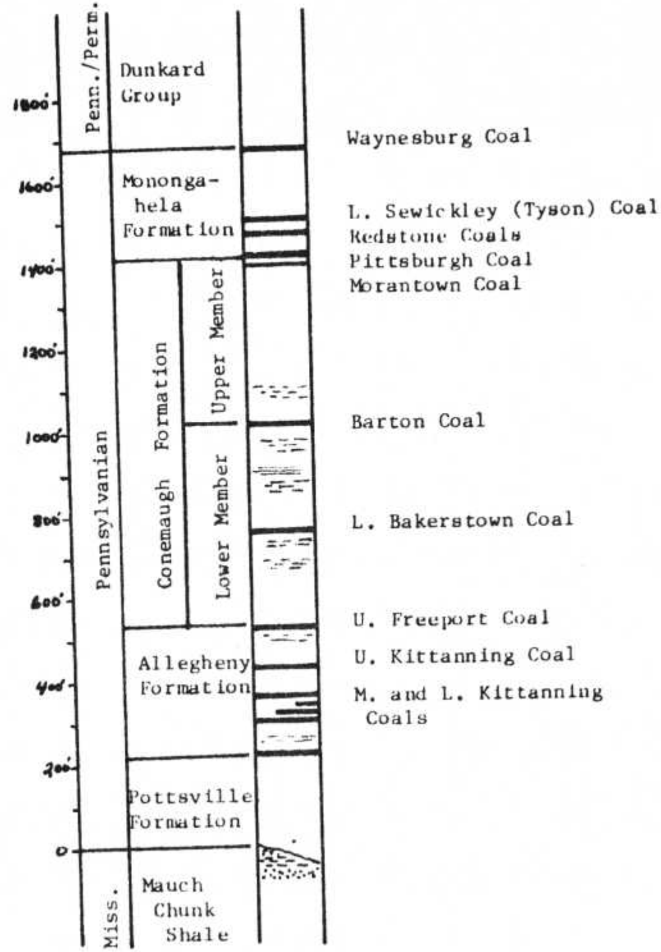


Figure 4. Generalized stratigraphic column of the coal measures of Maryland. Adapted from: Hollyday and McKenzie, p. 9.

Allegheny Front. On the east limb of the structure, dips in Devonian strata exposed in Jennings Run to the northeast of Frostburg reach 68°W, but decrease to 28° W at the Hampshire (Devonian) -- Pocono contact, to 17° W at the Pocono-Greenbrier contact, and to 13°W at the Mauch Chunk-Pottsville contact (Clark, 1905, p. 263), before flattening out toward the basin center. On the west limb of the syncline dips increase only to a maximum of 12°to 15°(Clark, 1905, p. 263).

The axis of the Georges Creek Syncline is unevenly inclined along its course through the basin. In some respects, the general configuration of the syncline is analogous to a canoe that has a transverse bend in the middle such that the canoe that the canoe ends are unevenly elevated. The upward pitch of the folds axis is the most apparent in the northern end of the syncline since virtually all of the coal measures come to the surface in that direction (Clark, 1905, p. 263). A more gentle pitch of the fold axis occurs in the southern end of the Georges Creek basin with the result that the structural low point in the center portion of the basin just to the south of Frostburg (Hollyday and McKenzie, 1973, p. 8). The overall structural configuration of the basin was used to best advantage with the construction of the drainage tunnel/ditch network that will be described further below.

Topographically, the Georges Creek Basin is hemmed in by Dans Mountain/ Piney Mountain to the east and Big Savage Mountain to the west, both of which form prominent, linear ridges somewhat parallel to one another. Big Savage Mountain owes its topographic prominence to the same Pottsville sandstones that cap the Front, but which on Big Savage are exposed on the opposite limb of the syncline. The Frostburg townsite lies astride a drainage divide in the north central end of the Georges Creek basin that separates the Georges Creek watershed to the southwest from the Jennings Run watershed to the northeast. The latter stream joins Wills Creek at Corriganville.

The existence of coal in the Georges Creek valley was known by 1782 and perhaps much earlier (Clark, 1905, p. 223). For the first half century after discovery, exploitation of the coal was limited to the demands of the local market. The coal mining industry in the Georges Creek valley assumed greater importance as transportation for the mined coal improved. By the 1820's coal could be shipped from the Georges Creek area to the eastern markets by barges sent down the Potomac River (Clark, 1905, p. 223). With the completion of the C& O Canal and the B& O Railroad in the middle of the last century, the development of the Georges Creek coalfields came rapidly. From just over 2,100 tons mined in 1842, the annual tonnage produced from Maryland's coalfields rose steadily through the remainder of the nineteenth century to reach a peak of 5.5 million tons in 1907 (Vokes and Edwards, 1974, p. 106). Thereafter, however, production from the Maryland coalfields began a steady decline at nearly the same rate it had risen. Labor problems, national economic conditions, changes in energy preference/consumption patterns and the exhaustion of the thicker and more easily mined coals all served to promote the rapid decline in Maryland coal production. In 1954 only 0.4 million tons was produced (Vokes and Edwards, 1974, p. 106) which was the lowest total since 1853 (Clark, 1905, p. 236), excepting the two years the Civil War seriously hampered coal production.

As the decline in coal production settled in, a basic shift in the methods of coal mining served to eventually effect a moderate reversal in the production totals. Strip mining of shallow depth coal seams along the basin edges had begun in the 1940's and by the 1960's became virtually the sole method of coal mining in the Georges Creek basin. The modest resurgence was spurred by a mid-1940's U.S. Bureau of Mines drilling program (Toenges, et. al. 1949) that assessed the strip mining potential of basin margin coal seams below the Pittsburgh ("Big Vein") seam in the Conemaugh, Allegheny, and Pottsville Series. (Fig. 4) To the present day, the report serves as a useful beginning point in preliminary assessments of strippable coal potential.

The most important seams mined at present include the Bakerstown, Morantown, Redstone, Franklin, Sewickley (Tyson), Waynesburg, and the Pittsburgh (Abar, 1983, p. 5). There are no active deep mines in Allegany County and it seems unlikely that there will be any in the future. Most mining activity occurs on the sideslopes of Big Savage and Dans Mountains where dips of the strata which are steeper than the ground surface slope cause the coal to lie near the ground surface. Most strip mine operations are small, with less than six employees actively engaged in the coal extraction process itself. Most operators remove the overburden using draglines with buckets of twenty cubic yards or less, the exception to this being the mine using a 27 cubic yard shovel that will be seen at Stop 4 on the field trip. The exposed coal is dug using either small shovels or front-end loaders. Production from the Pittsburgh seam, either from pockets too shallow to have been deep-mined or extraction of pillars left from the days of underground mining, still dominates the annual tonnage mined in the Georges Creek basin just as it did in the days of deep mining.

The Pittsburgh ("Big Vein") Coal occurs only in the Georges Creek/Upper Potomac Basin of the Maryland coalfields because of the greater depth of folding in the syncline. This coal originally was called the "Fourteen-foot Vein" because of its regular occurrence in that thickness in the southern portion of the Georges Creek valley (Clark, 1905, p. 531). Local pockets of coal as thick as 22 feet have been found in southern Georges Creek area (Swartz and Baker, 1920, p. 72). Generally the thickness decreases to the northeast in the basin, such that at Frostburg the coal runs 8 to 9 feet in thickness (Clark, 1905, p. 532).

> Near the northern end of the basin the "Big Vein" underlies the town of Frostburg, but close to the northern, eastern, and western borders of the town erosion has brought it to the surface, so that its outcrop is entered and mined by drifts and slopes in the mines of the Consolidation, Union, and other mining companies. From Frostburg... (south) ... a distance of four miles the "Big Vein" is beneath the surface and outcrops only on the edge of the basin, the greatest width of which is three and a half miles. At ... (four miles south)... Georges Creek has cut through to this coal bed, and from ... (here)... southward to Westernport that creek and its tributary streams have eroded their courses ... into the underlying measures exposing one after

another of the lower Conemaugh and Allegheny series of coal beds, leaving numerous detached knobs of "Big Vein" coal of greater or less area, which outcrop high up on the hills on both sides of the Georges Creek valley. (Clark, p. 531)

Coal mining was chiefly by the room and pillar method. The amount of coal extracted ranged from less than 50 percent to more than 85 percent (Clark, 1905, p. 539). The difference in coal recovered appears to be related to a variety of factors including: skill of the work force, activeness/idleness of the mine relative to either coal market prices or labor strife, and early preference for the best coal, the latter resulting in thinner seams between partings being left unmined and later unrecoverable.

Drainage of mine workings in the Georges Creek valley was handled in several different ways. Since water percolated through the overburden at an average rate of six gallons per acre each minute (Swartz and Baker, 1920, p. 170), drainage considerations were an obvious necessity. In the southern portion of the Georges Creek valley where the Pittsburgh coal outcropped above the valley floor, drainage was easily accomplished by the construction of drifts into the coal bed, the drift opening wisely being located at the lowest point on the property being developed (Clark, pp. 549-550). Gravity-drainage was cheaply accomplished by mining upslope/updip from that point.

In the northern portion of the Georges Creek valley from Frostburg to Midland different measures were required. A network of tunnels and ditches were constructed to drain mines and to supplement and eventually replace pumps. The longest of these tunnels, the Hoffman Drainage Tunnel, was completed in 1906. This tunnel is over two miles in length and has an average grade of .3551 percent (Swartz and Baker, 1920, p. 170) Its underground beginning point is in the structurally lowest place in the Pittsburgh workings about four miles south of Frostburg. The tunnel runs east-northern to an outlet on Braddock Run near Clarysville. Connecting ditches in the various mines of the Consolidation Coal Company collected water to be drained out through the tunnel. Later, workings in Sewickley (Tyson) coal which lies slightly more than 100 feet stratigraphically above the Pittsburgh seam were added to the Hoffman drainage network by boring holes from the ground surface through the floor of the Sewickley workings to the Pittsburgh workings (Hollyday and McKenzie, 1973, p. 13). Eventually more than 13 miles of tunnels and ditches effectively drained over 17 square miles of mine workings (Hollyday and McKenzie, 1973, p. 13; Swartz and Baker, 1920, p. 170). The tunnel still functions very effectively in draining the abandoned underground workings. A strip mine operation less than a mile southwest of Frostburg that is removing pillars left in the Pittsburgh seam rarely has any water for their pits. Further, subsidence in the strata above the Pittsburgh workings resulting from pillar removal has allowed the tunnel to divert surface drainage from as much as the northern third of the Georges Creek watershed (Slaughter and Darling, 1962, p.130). Thus, the drainage area of the tunnel may significantly exceed the amount generally reported.

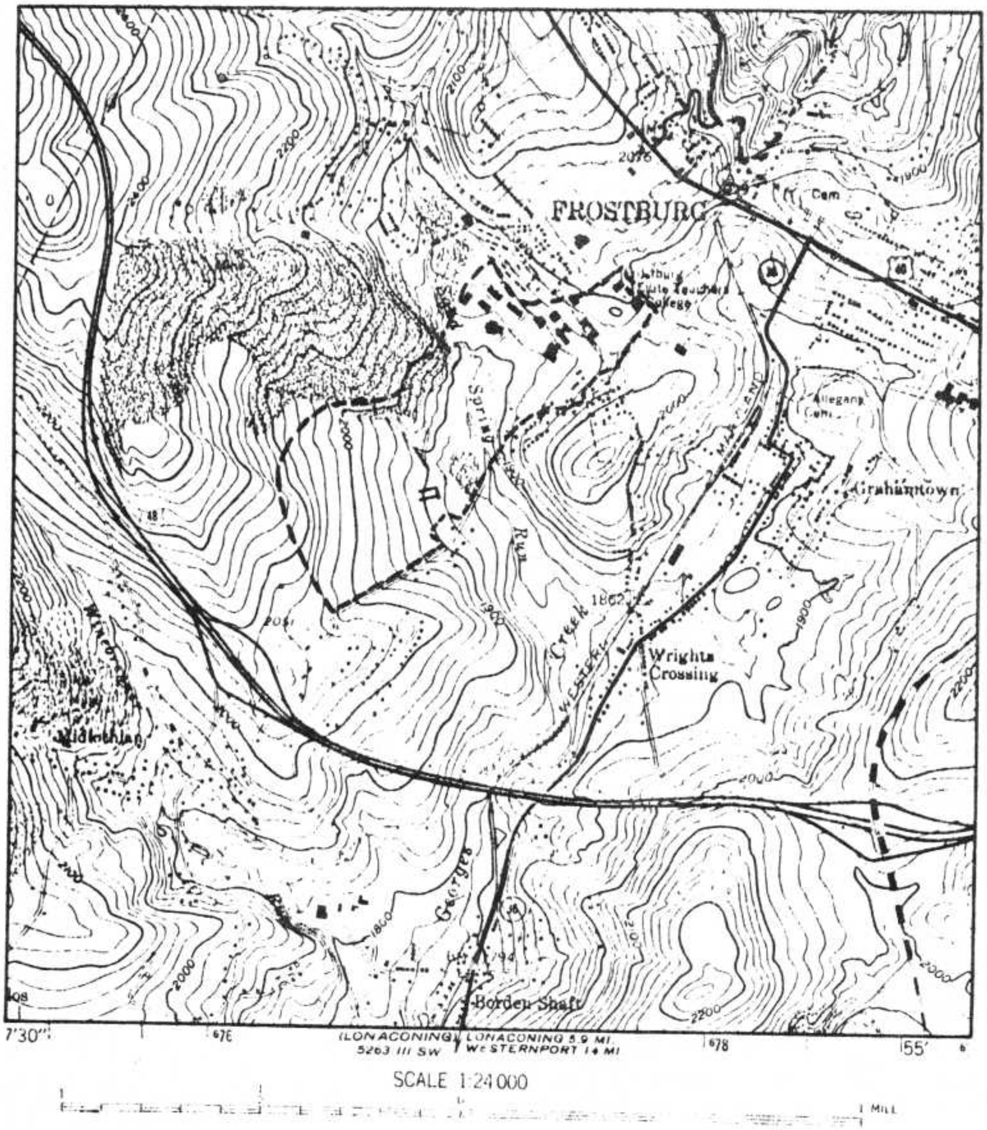


Figure 5. Frostburg State College campus in relation to the town. Portion of the Frostburg 1:24000 quadrangle.

The Frostburg townsite and the 220 acre campus of Frostburg State College which is located on the southern edge of the town (Fig. 5) lie over abandoned mine workings in the Pittsburgh and Tyson seams. Data on the occurrence of those coals beneath the campus has come from direct observation of drilling in 1970. At that time, a drilling/grouting program was undertaken to mitigate the campus' mine subsidence problem. A combination of concrete and fly ash mixed to a watery slurry consistency was pumped into the abandoned workings where they were found beneath campus buildings. The original projected volume of fly ash grout to be injected was doubled before the project was terminated. From this program, data suggest that the Pittsburgh and younger coalbeds dip about 7^{o}E beneath the campus. The Pittsburgh seam ranges from 8 to 10 feet in thickness and lies from 75 to 90 feet below buildings in the west campus area. In the east campus area this same coal lies 256 feet below the campus and was 14 feet thick in places. Pillar/void spacings suggested coal recovery in the range of 50 to 70 percent.

A second coal once deep mined beneath the present campus area is the Tyson. This seam runs 3 to 4 feet in thickness and lies stratigraphically about 100 feet above the Pittsburgh. Fewer voids were encountered in this seam and beneath the campus, recovery probably ranged from 30 to 50 percent. Voids in the Tyson were encountered in the central and eastern campus areas.

Evidence of subsidence can be found on many of the campus buildings, both on the upper, older portion of the campus nearer to town as well as on the lower, newer portions of the campus. Most evidence found is in the form of cracks in floors or which run diagonally up masonry walls. Only in recent years has the State of Maryland begun to carefully explore the subsurface before construction. In June of 1985, the new administration building trembled on the upper floors to the point that file drawers rolled open, objects on desks moved, and freshly painted walls developed new cracks, probably as a result of ground subsidence, though examination and interviews could neither prove or disprove this to be the cause. No plans have been made to determine whether mine subsidence was the cause for the phenomenon that affected only this one building or the extent to which future subsidence could affect the structure. Further, architects for the state continue to design buildings with flat roofs which on unstable ground are virtually certain to develop leaks. The campus circumstance provides an interesting example of where the lessons of environmental geology have been poorly learned.

Coal Geology and Land Reclamation of the Georges Creek Region, Maryland

Trip Leader :
Thomas W. Small

The places to be visited on this field trip include roadcuts, overlooks, abandoned/reclaimed mine sites, and active mine sites. During the course of our trip we will look at the strata of the Georges Creek Basin margins as well as examine strata in the basin proper. All exposures/stops on this trip are within short distances from the town of Frostburg (Fig. 6). Some of the places to be visited are on private property where permission for entry must be secured beforehand. Please respect those property rights and also use your best judgement when near highwalls or climbing over steep terrain.

We would like to acknowledge the assistance of the following individuals in the details involved in setting up this field trip: Dr. Dave Brezinski of the Maryland Geological Survey for his descriptions of the strata exposed in the National Freeway cuts at Big and Little Savage Mountains, Jack Beuthin of the Geology Department at the University of North Carolina for the details on the Pocono sequence at the Little Savage roadcut on the National Freeway which was a significant portion of his nearly completed Master's thesis for Dr. John Dennison of that institution, John Carey of the Maryland Coal Association for his assistance in securing contacts with member mine operators, George Beener of the Beener Coal Company in Barton to allow us to visit their active minesite, and Dr. Lorie Molitor of Towson State University for the opportunity to show some of the geology of the Western Maryland area. Thank you for coming! Welcome to Frostburg!!

Leave Frostburg State College to south on Midlothian Road and enter Freeway at Exit 33 West. Continue westbound on Freeway to top of mountain. Along the way there is an excellent view to the right (north) of the town of Frostburg and the northern part of the Georges Creek Basin. The reclaimed strip mine site to your right is part of the Winner Brothers operation. Three coals are extracted in these workings, the Sewickley (Tyson), the low quality (bony) Redstone, and the pillars in the Pittsburgh left over from the days of underground mining.

STOP 1. BIG SAVAGE MOUNTAIN ROADCUTS ON NATIONAL FREEWAY

Big Savage Mountain is a prominant ridge that is formed from the scarp at the end of the western limb of the Georges Creek Syncline. This same ridge extends northeastward into Pennsylvania on the western limb of the Wellersburg Syncline (the Pennsylvania extension of the Georges Creek structure) to near the hamlet of Madley. This same ridge also extends southwest into southern Garrett County and on into West Virginia to near Parsons, in these latter locations it is known as Backbone Mountain. The northeast to southwest extent of this ridge is approximately 75 miles.

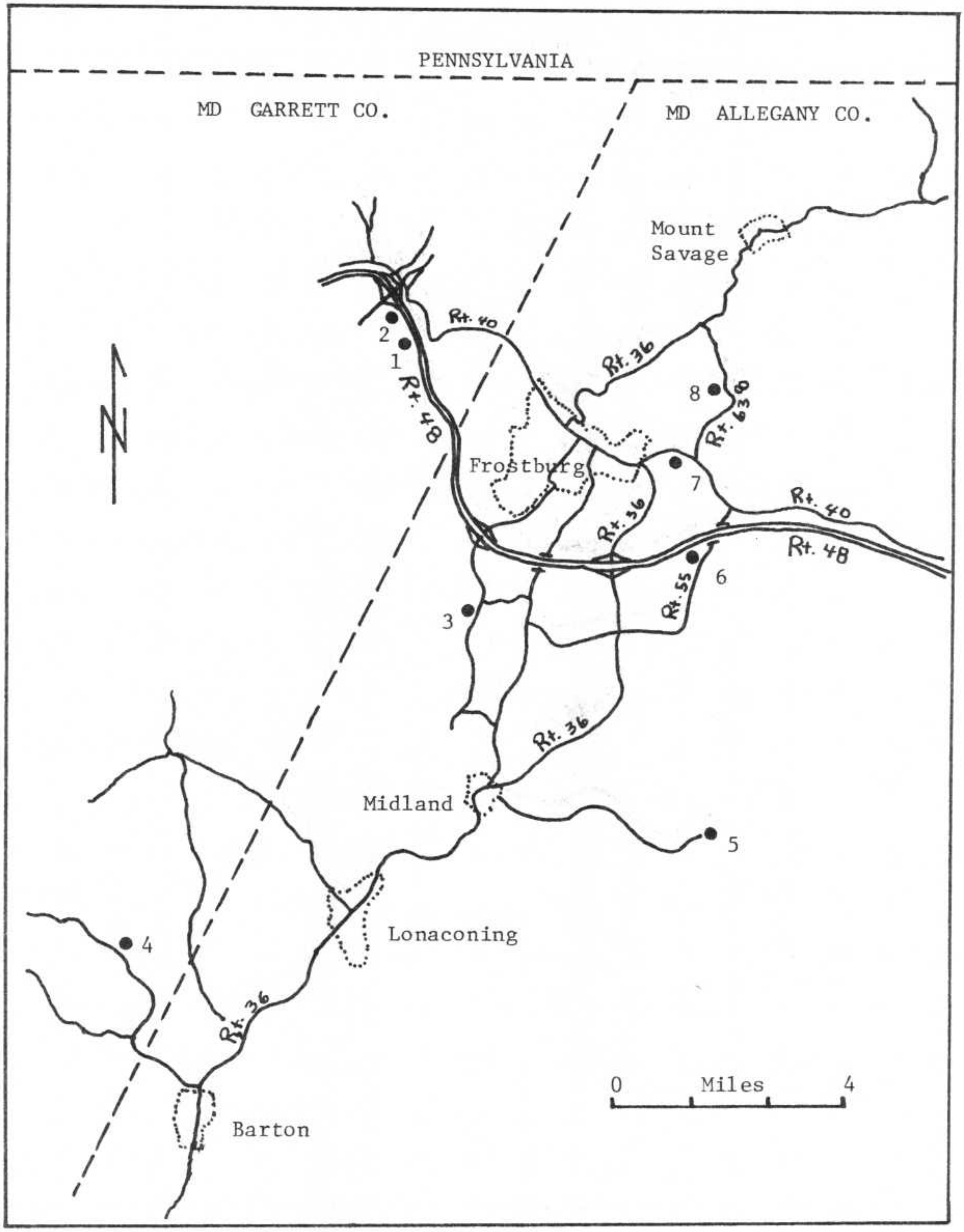


Figure 6. Location of field trip stops in the Frostburg area.

The western end of this exposure contains nearly 75 feet of reddish-brown and greenish-gray shales and siltstones and buff to reddish brown sandstones, some cross-bedded, of the Mauch Chunk formation. The conspicuous center portion of the cut exposes almost 240 feet of the Posstville formation which contains primarily sandstones, shales, and several thin coals at this location. The Sharon Sandstone member which lies at the base of this formation is the stratigraphic unit that caps many of the prominent ridge tops in this portion of the Appalachian Plateau Province. The eastern end of the cut, exposes just over 260 feet of strata belonging to the Allegheny formation. Both the basal and top members of this formation, the Lower Mount Savage and the Upper Freeport coals, respectively, are exposed here. Though mostly concealed, the Mahoning Sandstone of the Conemaugh formation is partly exposed at the extreme end of the cut through Big Savage Mountain.

The following description of the Big Savage Mountain roadcut on the National Freeway has been supplied by Dr. Dave Brezinski of the Maryland Geological Survey who is in the process of revising the 30 year old map for Allegany County. BEWARE OF FREEWAY TRAFFIC - KEEP OFF OF FREEWAY.

Base - West end of roadcut

MAUCH CHUNK FORMATION

Thickness (cum. thick.) feet	meters	
33.5 (33.5)	10.1 (10.1)	Shales and siltstones, some with thin sandy interbeds, reddish-brown and greenish-gray coloration.
14.0 (47.5)	4.2 (14.3)	Grayish-green medium grained argillaceous sandstone with basal lag conglomerate, erosional base; cross-bedded throughout with a few shale beds at top.
27.0 (74.5)	8.1 (22.4)	Shales, siltstone, and mudstone, greenish-gray to reddish-brown in coloration.
		POTTSVILLE GROUP
9.0 (83.5)	2.7 (25.1)	Sharon Sandstone: tan cross-bedded medium to coarse-grained gray.
2.0 (85.5)	0.6 (25.7)	Grayish-green siltstone.
15.0 (100.5)	4.5 (30.2)	Sandstone, grayish green friable, argillaceous, cross-bedded with coal streaks in lower portion, grades to tan, large-scale cross-beds, medium to coarse grained in top portion.
12.0 (112.5)	3.6 (33.8)	Siltstone and silty shale, greenish-gray throughout with thin grayish-red zone near top.
10.0 (122.5	3.0 (36.8)	Connoquenessing Sandstone: interbedded siltstone, grades laterally into tan cross-bedded sandstone, erosional base.
0.5 (123.0)	0.2 (37.0)	Grayish-green shale.

17.0	(140.0)	5.1	(4.20)	Tan to brown, large-scale cross-bedded, medium grained micaceous sandstone, irregular upper surface.
20.0	(160.0)	6.0	(48.0)	Grayish-green shale with lenses and nodules of silty carbonate, grading into interbedded silty shales and medium grained sandstone beds that run 2-3' (.6-.9m) in thickness, shaly beds in top grade laterally into siltstones.
41.0	(201.0)	12.3	(60.3)	Grayish-green to tan cross-bedded quartzone sandstone, medium to coarse grained, conglomeratic at base with a few coal stringers, siltstone beds near top.
5.0	(206.0)	1.5	(61.8)	Interbedded dark gray shale and gray medium grained sandstone, coal stringers in sandstone and plant fragments in shale.
29.0	(235.0)	8.7	(70.5)	Grayish-green cross-bedded sandstone with coal streaks, medium grained, with dark gray sandy shale 1.0' (0.3 m) thick at midpoint.
13.0	(248.0)	3.9	(74.4)	Interbedded dark gray shales and tan, well sorted, cross-bedded sandstones.
37.0	(285.0)	11.1	(85.5)	White, well sorted, coarse grained, cross-bedded sandstone, interval grades to light gray medium grained sandstone with coal stringers and logs near middle.
3.0	(288.0)	0.9	(86.4)	Black carbonaceous shale with thin coals (mercer?)
25.0	(313.0)	7.5	(93.9)	Homewood Sandstone: white, coarse grained, friable, cross-bedded sandstone, locally conglomerate.
				ALLEGHENY GROUP
4.0	(317.0)	1.2	(95.1)	Lower Mount Savage Coal: black shale and 2' (.6m) coalbed.
17.0	(334.0)	5.1	(100.2)	Upper Mount Savage Underclay: white to mottled clay with thin siliceous beds.
15.0	(349.0)	4.5	(104.7)	White to tan coarse grained sandstone with thin shale interbeds.
3.0	(352.0)	.9	(105.6)	Dark gray carbonaceous shale, contains plant fragments.
3.5	(355.5)	1.1	(106.7)	Lower Kittanning Coalbeds: two coals separated by a 1.0' (.3m) carbonaceous shale.
17.0	(372.5)	5.1	(111.8)	Tan, medium grained, cross-bedded argillaceous sandstone with coal fragments at base.
3.0	(375.5)	.9	(112.7)	Black silty shale.
20.0	(395.5)	6.0	(118.7)	Tan argillaceous sandstone which upsection grades into a light gray claystone thence into a medium to dark gray silty shale with a few coal stringers.

2.0 (397.5)	.6 (119.3)	Light gray to tan underclay.
2.5 (400.0)	.8 (120.1)	Coal.
17.0 (417.0)	5.1 (125.2)	Medium gray play siltstone with plant fragments grading upward into a shale/claystone into a gray shale with ironstone nodules.
1.0 (418.0)	0.3 (125.4)	Shaly coal.
25.0 (443.0)	7.5 (132.9)	Dark gray shale interbedded with siltstone and sandstone grading into a platy micaceous siltstone in top half.
13.0 (456.0)	3.9 (136.8)	Medium dark gray mudstone grading upward into a tan siltstone with sandy layers and into a tan claystone at top.
20.0 (476.0)	6.0 (142.8)	Tan, medium grained argillaceous sandstone with coal fragments and shale pebbles at base.
7.0 (483.0)	2.1 (144.9)	Medium gray to tan claystone, mostly concealed.
32.0 (515.0)	9.6 (154.5)	Tan, medium grained, cross-bedded sandstone, becomes shaly at top.
44.0 (559.0)	13.2 (167.7)	Grayish-green shale grading into tan interbedded shale, siltstone and thin sandstone beds, mostly concealed.
- (559.0)	- (167.7)	Coal blossom.
10.0 (569.0)	3.0 (170.7)	Bolivar Clay: gray claystone.
6.0 (575.0)	1.8 (172.5)	Upper Freeport Coal: coal, shaly at base, mostly concealed.
		CONEMAUGH GROUP
25.0 (600.0)	7.5 (180.0)	Mahoning Sandstone: tan, cross-bedded sandstone with locally shaly interbeds, the upper 10' is mostly concealed

Board buses to continue trip.

The valley between Big and Little Savage Mountains is a strike valley that coincides with the Greenbrier formation, the base of the overlying Mauch Chunk and the top of the underlying Pocono formation. The Greenbrier formation contains two limestone zones with intervening shaly redbeds and at this location is estimated to be about 375' (112.5 m) thick.

Several large swampy acres lie in this strike valley, Cranberry Swamp to the north of our present location and Callahan and Pine Swamps to the south of us. These swamps are noted for their unusual flora in that they contain relict plant species that are survivors from the harsh alpine tundra type of climate that existed here in the late Plestocene to around 14,000 years B.P. Overflow from these swamps is into the headwaters of the Savage River.

The Savage River drains most of the area shown with Devonian (Hampshire and Chemung) rock outcroppings to the west of the Georges Creek Basin in between the Georges Creek Basin/Syncline and the shallow Castleman Basin/Syncline to the northwest. The Savage River empties into the North Branch of the Potomac River near Westernport. Drainage of the Deer Park Anticline north of highway routes 40/48 in Maryland and in southern Garrett County is into tributaries of the Monongahela/Ohio Rivers.

Exit Freeway to Exit 29 (Finzel Road). Turn left, cross freeway overpass bridge and re-enter Freeway eastbound with left turn. Park on entry ramp.

STOP 2. LITTLE SAVAGE ROADCUT ON NATIONAL FREEWAY

Discussion of Hampshire-Pocono exposure in roadcut through Little Savage Mountain near Finzel, Maryland.

Jack D. Beuthin
University of North Carolina at Chapel Hill

This exposure (the Finzel section) of the upper Hampshire Formation and lower Pocono Formation is a key section for my research on the deposition of the Pocono Formation in this area. Below are some descriptive and interpretive remarks about the Pocono Formation followed by a listing of some of the interesting sedimentary features present in the Finzel section.

In Garrett and Allegany counties, Maryland, the Pocono Formation (dominantly grayish and greenish strata) is conformably underlain by the Hampshire Formation (dominantly red beds) and is conformably overlain by the Greenbrier Limestone. Several tens of feet of Hampshire red beds are exposed in the base of the Finzel section and the Hampshire-Pocono contact is quite sharp. The strike valley that is directly to the east between Little Savage Mountain and Big Savage Mountain is formed on the nonresistant Greenbrier Limestone. Little Savage Mountain is a Pocono-supported homoclinal ridge along the eastern flank of the northeast-trending Deer Park anticline. Stratigraphically, the Pocono Formation is a bipartite unit. The upper part, named the Burgoon Sandstone Member (not exposed in the Finzel section), is an unfossiliferous (except for plant remains), massive sequence dominated by cross-bedded sandstone. The lower part, which has no formal name, is a marine-fossiliferous sequence of intercalated shale, siltstone, sandstone, polymicitic diamictite and minor coal. Most of the lower Pocono Formation (sub-Burgoon) is exposed in the Finzel section and consequently the remainder of this discussion will focus on the lower Pocono.

Historically, the Pocono Formation has been considered to be Mississippian in age. My work, which is chiefly concerned with the origin of marine transgressive facies in the Pocono Formation, has shown that much of the lower Pocono is actually uppermost Devonian in age.

During the Late Devonian, the westwardly prograding Catskill clastic wedge built a subaerial coastal plain in this area. Just before the close of the Devonian, an eastward transgression of the Devonian epicontinental sea caused submergence of the Catskill coastal plain as far east as the present-day Allegheny Front (Devonian depositional strike roughly parallels present-day structural strike). Facies shifts associated with this transgression can be traced westward across the Appalachian basin into northern Ohio where the transgressive, black Cleveland Shale overlies the gray Chagrin Shale and underlines the gray Bedford Shale. It is most likely that the widespread "Cleveland" transgression was caused by a rise in sea level.

The Cleveland transgression is prominently developed in the Finzel section. Here, the Hampshire red beds, which are subaerial lower delta plain deposits, are succeeded by 70 feet of sparsely marine-fossiliferous, Pocono shale, siltstone and sandstone. The Pocono marine zone is overlain by Pocono non-marine sandstones and mudstones (fluvial channel and overbank deposits). Deposition of Pocono marine strata here occurred in a quiet coastal bay during the peak of the latest Devonian Cleveland transgression. Regional stratigraphic evidence indicates that there was a barrier island about 45 miles west of here which sheltered the coastal bay. Evidence for tidal sedimentation in the Pocono embayment is lacking. Rather, stratigraphic and lithologic evidence indicate that deltas prograded into this bay and filled it (note the general coarsening-upward character of the Pocono marine zone).

There are many sedimentary features that you may wish to focus on while examining this section. Mudcracks occur in many of the redbeds. Linguloid brachiopods can be found in the dark gray shales of the basel 35 feet of the Pocono Formation. Several kinds of bedding-plane trace fossils occur in the marine zone, especially on the bases of sandstone beds. Vertical Skolithos tubes are common in sandstone beds of the marine zone. Small siderite concretions occur in many of the dark shales. A variety of sedimentary structures are present in the fining-upward, channel-point bar sequence (about 55 feet of section) that directly overlies the Pocono marine zone. In the southern exposure, this sequence changes upward from a medium-to course-grained, cross-bedded sandstone at the base (note the scour structures and disconformable basal contact) to a fine-grained, planer-bedded sandstone which becomes a flaser- and wavy-bedded ripple-laminated sandstone and finally to a grayish-red, mud-cracked siltstone near the top.

The following detailed description of the Rt. 48 roadcut through Little Savage Mountain has been compiled by Dr. Dave Brezinski of the Maryland Geological Survey.

Base - west end of roadcut.

Thickness feet		(Cum. Thick.) meters		HAMPSHIRE FORMATION
10.2	(10.2)	3.1	(3.1)	Reddish brown and grayish green interbedded sandstone and siltstone.
5.0	(15.2)	1.5	(4.6)	Reddish brown to dark red siltstone.
2.0	(17.2)	0.6	(5.2)	Thinly bedded reddish brown siltstone and sandstone.
8.0	(25.2)	2.4	(7.6)	Grayish red mudstone.
5.0	(30.2)	1.5	(9.1)	Reddish brown to grayish red interbedded siltstone and claystone.
				ROCKWELL FORMATION (Pocono Group)
3.0	(33.2)	0.9	(10.0)	Grayish green very fine grained sandstone, argillaceous laminated, Skolithus
5.0	(38.2)	1.5	(11.5)	Interbedded very fine grained grayish green to gray sandstone with brachiopods, pelecypods and trace fossils, grades to gray claystone and then to shale.
1.0	(39.2)	0.3	(11.8)	Medium gray fine grained laminated sandstone with ball and pillow structure rippled or erosive low contact.

6.0	(45.2)	1.8	(13.6)	Interbedded very fine grained gray sandstone, laminated with trace fossils, grades to gray claystone and then to shale.
4.0	(49.2)	1.2	(14.8)	Grayish green with red/green mottles, very fine grained sandstone, micaceous, calcareous with cross-beds and cross laminations, mud cracks at base.
0.5	(49.7)	0.2	(15.0)	Grayish red to grayish green claystone.
4.0	(53.7)	1.2	(16.2)	Grayish green to gray fine grained argillaceous sandstone, mottled at base, Skolithus and brachiopods.
8.0	(61.7)	2.4	(18.5)	Dark gray claystone with thin lamination of siltstone and siderite, Linqula and plant fragments at base.
2.0	(63.7)	0.6	(19.1)	Medium gray fine grained argillaceous sandstone.
1.0	(64.7)	0.3	(19.4)	Dark gray claystone.
12.0	(76.7)	3.6	(23.0)	Medium gray to grayish green very fine grained laminated argillaceous sandstone with Skolithus bioturbated, sharp basal contact.
5.0	(81.7	1.5	(24.5)	Thinly interbedded grayish green sandstone, argillaceous and laminated, grades into claystone-shale.
2.0	(83.7)	0.6	(25.1)	Grayish green very fine grained calcareous sandstone.
3.5	(87.2)	1.1	(26.2)	Reddish brown to reddish gray laminated siltstone with laminations of gray shale near top.
5.0	(92.2)	1.5	(27.7)	Grayish green very fine grained sandstone with Skolithus and horizontal burrows.
6.0	(98.2)	1.8	(29.5)	Grayish green fine grained sandstone with waxy laminations, concretions, Skolithus; thinly interbedded with shale and siltstone at base.
1.0	(99.2)	0.3	(29.8)	Gray siltstone/shale.
3.0	(102.2)	0.9	(30.7)	Grayish-green argillaceous very fine grained sandstone with Skolithus and horizontal burrows.
18.0	(120.2)	5.4	(36.1)	Grayish-green to gray, medium to coarse grained cross-bedded sandstone with coal and plant fragments and erosional base.
19.0	(139.2)	5.7	(41.8)	Medium gray fine grained micaceous thinly bedded sandstone, rippled to planar bedded.
15.0	(154.2)	4.5	(46.3)	Thinly interbedded gray fine-grained wavy bedded sandstone and brownish gray shale/siltstone; mudcracks, flaser bedding evident.
7.0	(161.2)	2.1	(484.)	Reddish brown to reddish gray siltstone with a few sand stringers, dessication cracks.
25.0	(186.2)	7.5	(60.4)	Interbedded gray to grayish green to grayish red shale and siltstone with a few thin grayish green hematite stained sandstone beds, some mudcracking.
15.0	(201.2)	4.5	(60.4)	Greenish gray very fine grained micaceous sandstone with erosional base; coal and wood fragments at base, much more silty and argillaceous at top.
+25.0	(226.2)	+7.5	(67.9)	Covered, probably tan flaggy medium grained sandstone.

Board buses to continue trip

Enter Freeway eastbound and continue on Freeway to Exit 33, Midlothian Road. At this exit turn right at stop sign at ramp end and continue south on Midlothian Road. Bear right and then left at the next intersection. Continue South

STOP 3. WORKMAN FARM VISTA

At this brief stop, one can get a panoramic view of the Georges Creek Basin and at the same time gain an appreciation for the best and worst effects of coal extraction over the landscape. Within view on the valley floor are ruins of facilities left from the days of underground mining, these facilities are derelict and long abandoned. One can also see stockpiles and related facilities of Tower Resources. The now nearly dormant facility was very active in the mid-to-late 1970's and early 1980's. Active strip mines on both sides of the Georges Creek basin can be seen from this point, as well as abandoned mines, some reclaimed and others not. Dans Rock, the overlook of the Allegheny Front, can be seen in the far distance at the ridge crest.

Board buses to continue trip.

Continue south into the village of Carlos. Bear left and go through town. Turn right. Go through small village of Woodland and keep bearing left through town. At stop sign for Rt. 36, turn right and go south to the town of Midland. Continue south on Rt. 36 through Midland and also through Lonaconing. At the north end of the village of Barton bear right onto Butcher Run Road. Continue up this road past turnoff to left, go to Beener Coal Company.

STOP 4. BEENER COAL COMPANY

The Beener Coal Company is mining bituminous coal at this site on the west limb of the Georges Creek Syncline. Three coal seams are mined here. From the top down they include the Pittsburgh, which averages 5' (1.5 m) in thickness; the Little Pittsburgh, which averages 3.5' (1.1 m); and the Franklin, which averages 30' (0.9 m). The overburden depth to the Pittsburgh seam runs from 75' to 90' (22.5 - 27.0 m). Though the Pittsburgh seam is unusually thin at this place, it was deep mined in the days of underground mining and Beener Coal is in the process of extracting the "stumps and bottoms" (pillars and floor coal) left from the past. An additional 40' to 45' (12.0 - 13.5 m) of overburden is removed to reach the Little Pittsburgh Coal. Another 100' (30 m) of overburden is removed to reach the Franklin Coal which has a shale parting in it. A fourth seam, the Lonaconing Coal, is 2.0' (0.6 m) thick and lies beneath another 20' (6.0 m) of overburden. While some thought has been given to extracting this coal, actual mining of the seam on this site has not yet occurred. To reach the top three coals, high walls of 200' (60 m) are created (Fig. 7).

A unique feature of the Beener operation is the world's largest power mining shovel using "on-board" diesel-electric power generation. This innovative engineering technique developed by the owner/operator, George Beener, avoids a costly investment by the company in an electric substation and allows the shovel operator to maneuver the 650 ton shovel in the narrow ridges of Pickel Hill without concern for a trailing electric cable. The 27 cubic yard shovel is the largest in operation in the eastern coalfields.

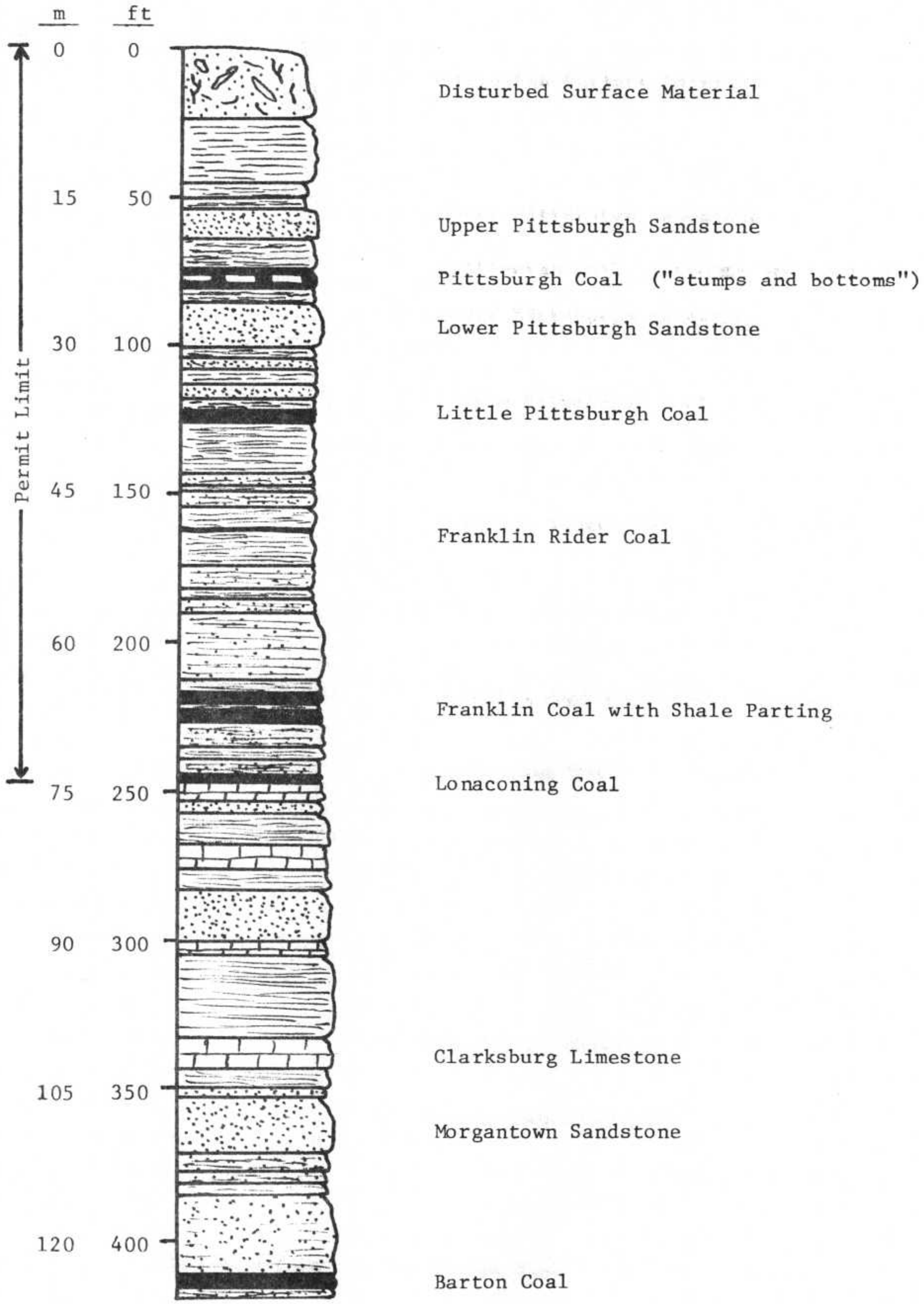


Figure 7. Stratigraphic column from drill core at Beener Coal Company. The Pittsburgh Coal is the base of the Monongahela Group. The Barton Coal is stratigraphically at the midpoint of the Conemaugh Group.

Beener Coal Company makes use of a variety of heavy equipment in its operation. In addition to the shovel described above, smaller power shovels and draglines are also used here. Overburden and topsoil are also moved by 100 ton trucks, while backfilling and grading are done with bulldozers. One can gain a quick appreciation here of the amount of investment needed for even a relatively small mining operation.

Board buses to continue trip.

Return down Butcher Run Road to Rt. 36. Turn left (north) and continue on Rt. 36 through the town of Lonaconing into the village of Midland. Turn right in Midland at the first opportunity, go one long block then turn left. Turn right onto Dans Rock Road and continue up this road to the summit, a distance of approximately 2.75 miles.

STOP 5. AND LUNCH BREAK DANS ROCK VISTA

Two panoramas useful to our purposes are available here. As one looks off to the east, the folded strata of the Ridge and Valley Province can be seen on the opposite side of the strike valley at the base of the Allegheny Front. From this vantage point one can see Fort Hill off to the south-southeast. Fort Hill is an asymmetrically folded anticline that is crested with the Oriskany Sandstone. The North Branch of the Potomac River, which flows to the north (left) before us disappears to the right (upstream) between Fort Hill and before us disappears to the right (upstream) between Fort Hill and Knobly Mountain in the distance. The town of Keyser, West Virginia, is out of view about 8 miles upstream from the north end of Fort Hill.

Off to the east (toward our left) is the southern end of Haystack Mountain. This ridge continues as Wills Mountain on the northern side of the Narrows of Wills Creek. Haystack Mountain/Wills Mountain is an asymetrically folded anticline that has been overthrust over Devonian strata by perhaps as much as 2000 feet along the Cresaptown fault. (An excellent description of this fault and strata exposed along the Allegheny Front can be found in John Dennison's contribution to the 37th Annual Field Conference of Pennsylvania Geologist, Penn. Geol. Survey, 1972). Haystack Mountain is created with the Tuscarora Sandstone. From our present vantage point, the city of Cumberland is off to the northeast out of our view behind Haystack Mountain.

Along the Allegheny Front from our lower left view to our lower right view can be seen the surface expression of strata of varying hardnesses that comprise the Allegheny Front. As we stand at this point overlooking the complex slope forms before us we are reminded the strata exposed at the Front are the edges of strata that comprise the east limb of the Georges Creek Syncline. From beneath your feet to the slope base in the Potomac Valley, dips on strata become increasingly vertical. Some excellent exposures of these steeply dipping strata can be seen in LaVale Plaza in the Hampshire formation (Field Trip B, Stop5)or along the National Freeway cut in Red Hill.

The sandstone at our feet is the Sharon Sandstone member, which is the basal unit of the Pottsville Group. Interesting solution cavities occur here on the outcrop. One might also notice the quasi-blockfield of sandstone near the base of the cliff which is somewhat suggestive of intense frost processes here in the late Pleistocene.

Behind us to the west can be seen the ridge crest of Big Savage Mountain on the opposite side of the syncline.

Board buses to continue trip.

Return down Dans Rock Road to the town of Midland. At the stop sign at the bottom of the hill turn right. Continue straight ahead and over bridge across the creek to Rt. 36. Turn right. Travel north on Rt. 36 to Vale Summit junction at blinker light. Turn right onto Vale Summit Road, Rt. 55. Continue north on this road through town of Vale Summit on to near National Freeway overpasses. Our next stop is on the west side of the road opposite Jenkins Autobody.

STOP 6. HOFFMAN DRAINAGE TUNNEL OUTLET

The outlet for the Hoffman Drainage Tunnel can be found in the wooded area just below the guard rail along the roadway edge. The tunnel was begun in 1903 and completed in 1906 to relieve the Consolidation Coal Company of the substantial costs involved in operating water pumps in their mines. The tunnel is slightly over two miles in length and runs at a grade of .35 percent. When originally completed the tunnel drained the workings in the Pittsburgh seam. As described elsewhere in the guidebook, the drainage area was extended to include workings in the Sewickley (Tyson) seam. The western entrance to the tunnel is in the underground at the structural low point in the Pittsburgh coal, which is located about 4 miles to the south of Frostburg. Some subsidence has occurred here at the eastern tunnel end such that the outlet is a short distance west of the original portal which is still in place. Stratigraphically the tunnel outlet is near the middle of the Conemaugh formation.

Through time, discharge from the tunnel has varied from as low as 3,900 to as high as 30,000 gpm. In 1947, caving of the tunnel reduced the flow to a mean rate of around 9,000 gpm (Slaughter and Darling, 1962, pp 130-131). Slaughter and Darling also report evidence that the tunnel may divert a substantial portion of the stream discharge from the northern third of Georges Creek.

Water quality of discharge from the tunnel varies with the discharge. The pH tends to become more acid as the discharge drops. In May 1958, the pH measured 6.7. At that same time, Slaughter and Darling also report the following parameters (in ppm): Ca - 104, Mg - 48, Sulphate - 455, Carbonate - 457, Non-carbonate hardness 440. Rocks on the streamfloor of Braddock Run are coated with an orange precipitate ("yellow-boy") that can be seen from the tunnel egress all the way to that streams' mouth at Wills Creek at the north end of the Narrows.

Board buses to continue trip.

Continue down Vale Summit Road to stop sign at intersection with Rt. 40 at Clarysville. Turn left onto Route 40, westbound. Travel west into Eckhart, formerly Eckhart Mines. The present town of Eckhart has grown to cover much of the surface previously occupied by one of the largest of the Consolidation Coal Company's mines. Several large tailings (gob) piles can be seen on the south (left) side of the highway as one travels through the town. Continue uphill past school to left. Just beyond motel on left (south) side of highway, turn left into reclaimed area.

STOP 7. RECLAIMED TAILINGS (GOB) AREA

The area before you was part of a large mine dump area. The underground workings were in the Pittsburgh seam which ran from 11' (3.3 m) to 13' (3.9 m) thick in this area. As was the practice in many of the mines of this area in those days gone by, the men were paid according to productivity. For each "acceptable" load of coal produced the men were given a ticket or token, commonly made of brass and stamped with a number and the mine company's logo. Too much apparent "bone" coal (shaly waste material), even if only on the top of that car load caused the load to be rejected by the foreman and dumped onto the gob pile with no credit for the wasted load going to the mine crew. Over a period of time the tailings (gob) piles grew quite large and also contained significant amounts of usable coal.

Several mine mouth areas around Frostburg have (gob) piles that contain reclaimable coal, even in today's depressed market. The site here in Eckhart has been one where there has been periodic interest in reclaiming the coal in the waste piles because of the growth of the community onto former mine company properties. Until a few years ago, the interest never got much beyond the discussion stage.

For a period of two or three years coal was reclaimed from the waste piles on this site. Village residents also expressed some hope that larger waste piles a short distance away would be reclaimed. The operator of this reclamation project discovered that he came under the same sorts of rules and regulations that applied to the traditional types of mining operations (e.g., posting bonds for permits, drainage control, etc.). This discovery promptly took all the profit margin from the reclamation activity and the site was graded, seeded, and closed. It would appear unlikely that the waste pile reclamation can occur here or at other points in the Georges Creek Basin given the present economic conditions and federal and state regulations as they applied to this kind of operation.

Board buses to continue trip.

From the last stop, turn right and proceed east (downhill) on Route 40. Within less than one-half mile, turn left onto Rt. 638 and proceed approximately one mile to a reclaimed strip mine on left.

STOP 8. RECLAIMED STRIP MINE

Coal was extracted here by strip mining from about a 100 acre permit. With the cessation of mining activity, the area was backfilled, graded, and revegetated. To comply with federal and state regulations, all mined lands must be returned to the approximate original contour and revegetation established in accordance with an approved reclamation plan using prescribed techniques.

This area has been successfully reclaimed for pastureland use. It demonstrates the successful application of a multiple land-use concept whereby the mineral (coal) has been extracted and the land has been restored to a condition environmentally and aesthetically consistent with the surrounding countryside.

Board buses to continue trip.

From the strip mine entrance, turn left and continue north on Rt. 638. As we descend the slopes of Federal Hill, one can get a nice overlook of the Jennings Run valley in the northern part of the Georges Creek Basin. At junction with Rt. 36, turn left and proceed southeast toward Frostburg

About 1.2 miles from the Rt. 36 - Rt. 638 junction we come into the small hamlet of Zihlman. On your right as we cross the railroad tracks is the now closed facilities of Kaiser Refractories. The industry here and to the north of us in the town of Mount Savage were originally developed to take advantage of the abundant, high quality underclays. In recent years, refractory clays were no longer mined here and were shipped in from outside the region. The brickyard in Mount Savage is still in operation, but these facilities have been closed since about 1980.

Continue south on Rt. 36 toward Frostburg. The hill we will ascend is the drainage divide between Jennings Run to the northeast and Georges Creek to the southwest that the town of Frostburg lies astride.

At the traffic light in Frostburg, we have come to the junction with Rt. 40. Continue straight ahead for four blocks and turn left onto College Avenue. At entrance to the college road turn right and go down hill to our point of origin.

Bibliography

Abar, A., 1983, Annual Report of the Maryland Bureau of Mines (61st), 34 p.

Berryhill, Jr., H.L., et. al., 1956, "Geologic Map of Allegany County Maryland Geological Survey (Baltimore), 1:62, 500 scale.

Clark, W.B., 1905, Report on the Coals of Maryland. Maryland Geologic Survey (Baltimore: Johns Hopkins Press), 651 p.

Gas Research Institute (GRI), 1980, Summary of Geologic Feature of Selected Coal-Bearing Areas of the United States. Prepared by TRW, Inc. (McLean, Virginia), December, 1980, 110 p.

Hollyday, E.F. and S.W. McKenzie, 1973, Hydrogeology of the Formation and Neutralization of Acid Waters Draining from Underground Coal Mines of Western Maryland Maryland Geological Survey, Report of Investigations No. 20, 50 p.

Slaughter, T.H. and J.M. Darling, 1962, The Water Resources of Allegany and Washington Counties. Maryland Geological Survey, Bulletin No. 24 (Baltimore: Waverly Press), 408 p.

Swartz, C.K. and W.A. Baker, Jr., 1920, Second Report on the Coals of Maryland. Maryland Geological Survey (Baltimore: Johns Hopkins Press), 296 p.

Toenges, A.L., et. al., 1949, Investigation of Lower Coal Beds in Georges Creek and North Part of Upper Potomac Basins, Allegany and Garrett Counties, Maryland. Washington: U.S. Bureau of Mines, Technical Paper 725, 142 p.

Vokes, H.E. and J. Edwards, Jr., 1974, Geography and Geology of Maryland. Maryland Geological Survey, Bulletin No. 19 (Baltimore: Johns Hopkins Press), 242 p.

INTRODUCTION

Loretta L. Molitor, Towson State University

On this field trip we will view rock evidence for major changes in depositional environments that occurred through much of the Paleozoic in this part of the central Appalachian basin. The Appalachian basin is an elongate and complex depocenter which extends south from the Canadian Shield to central Alabama and west from the Piedmont to central Ohio (Figure 1). Much of the area is now occupied by mountains and plateaus but throughout most of the Paleozoic era it was a downwarping area periodically occupied by shallow seas. The great thickness of sediment along the margins of these seas serve as a sensitive record of changing conditions in the depositional basin and sediment source areas. The lower part of the section is dominated by carbonate while in the upper portion clastic sediments are more common (Colton, 1970). The formations exposed in the eastern portion of the basin reveal three major clastic sequences. Each carbonate sequence marks the culmination of a major transgression of the sea. The overlying clastic sequences begin with major shale units and coarsen upward to end with fluvial and/or deltaic deposits. The sandstones and conglomerates (Tuscarora and Pocono) of these units provide the resistant rocks which form the dominant ridges of present day topography. The coarsening upward clastic sequences record major regressions of the sea interpreted as responses to prograding shorelines due to increased sediment output from orogenic highlands forming to the east (Figure 2).

The brief depositional history given below and in Figure 3 is based on the descriptive overview given by Colton (1970) and summary of tectonic history given by Fichter and Poche (1979). The Cambrian-Ordovician carbonate sequence that begins the Paleozoic story of the basin is not included in our field trip area but is exposed in pastures, stream cuts, quarries, and railroad cuts in the Hagerstown Valley. The lower part of this sequence is largely dolomitic and the upper part is limestone and argillaceous limestone. The clastic Ordovician sequence that conformably overlies the carbonates reaches maximum thickness along the northeastern edge of the basin and thins to the north, west and southwest. The Martinsburg, the major shale unit of this sequence, has been interpretted as a thick set of turbidites deposited in a deepening off-shore basin indicating the beginning of tectonic activity in the area. The sequence coarsens upward with the deposition of near shore sands, and the deltaic and fluvial sandstones and shales of the Oswego and Juniata formations. The contact between these units and the overlying Silurian clastics (Tuscarora) is disconformable throughout much of the basin.

In northeastern Pennsylvania the Juniata and Oswego are missing and an angular unconformity exists at the contact between the Martinsburg and overlying Silurian clastics. This may be interpreted as evidence of not only erosion during a regression but an indication of tectonic activity associated with the Taconic orogeny. While the Early Silurian clastics in the northeastern part of the basin are mostly coarse sandstones and conglomerates the units thin toward the center of the basin where they are replaced by finer sandstones, siltstones and mudstones. Such finer grained units also become more common in the northeastern area as the Taconic source lands wore down during the Middle Silurian.

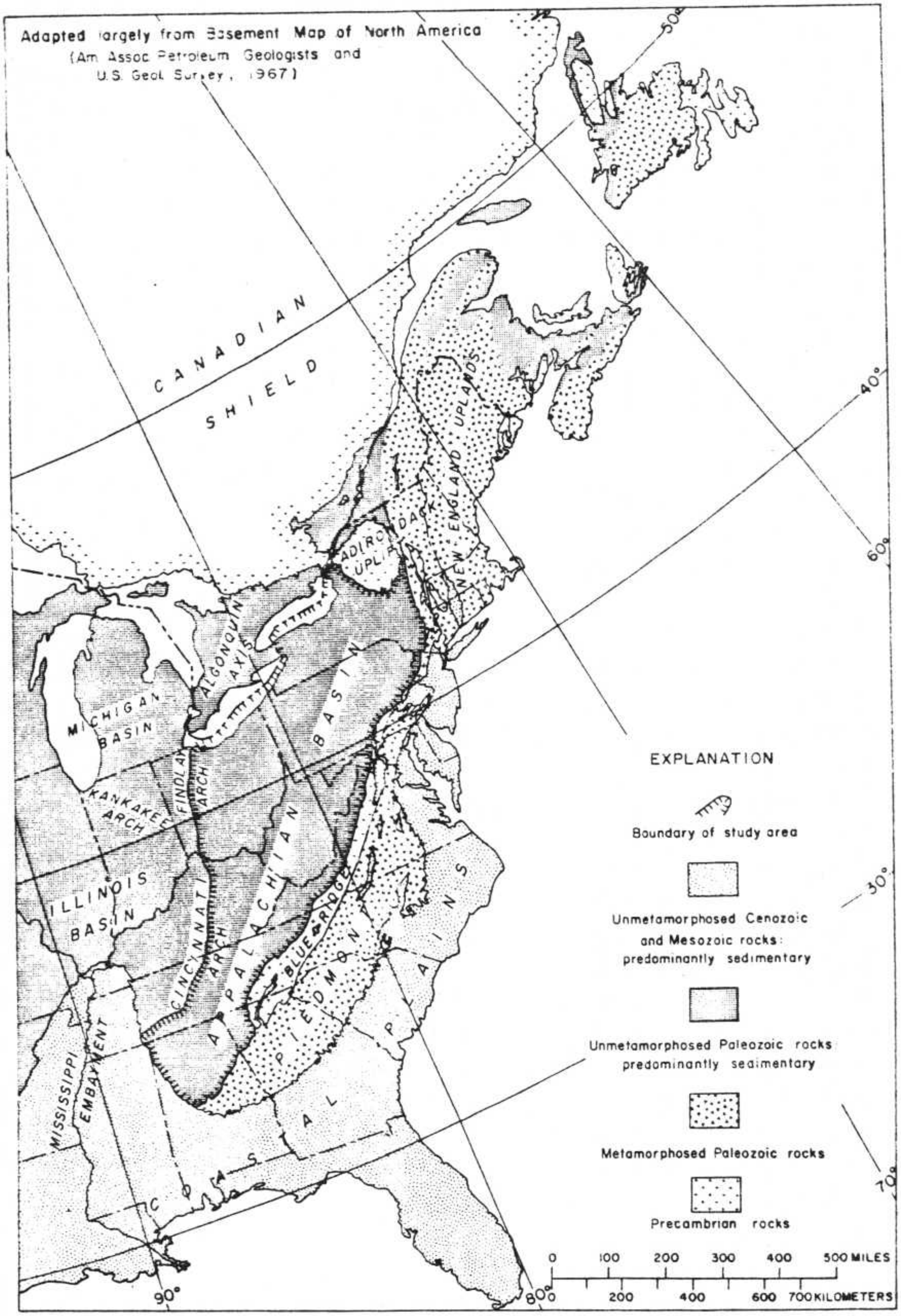


Figure 1. Map of Eastern North America relating major geologic and physiographic features to the study area.

(From Colton, 1970)

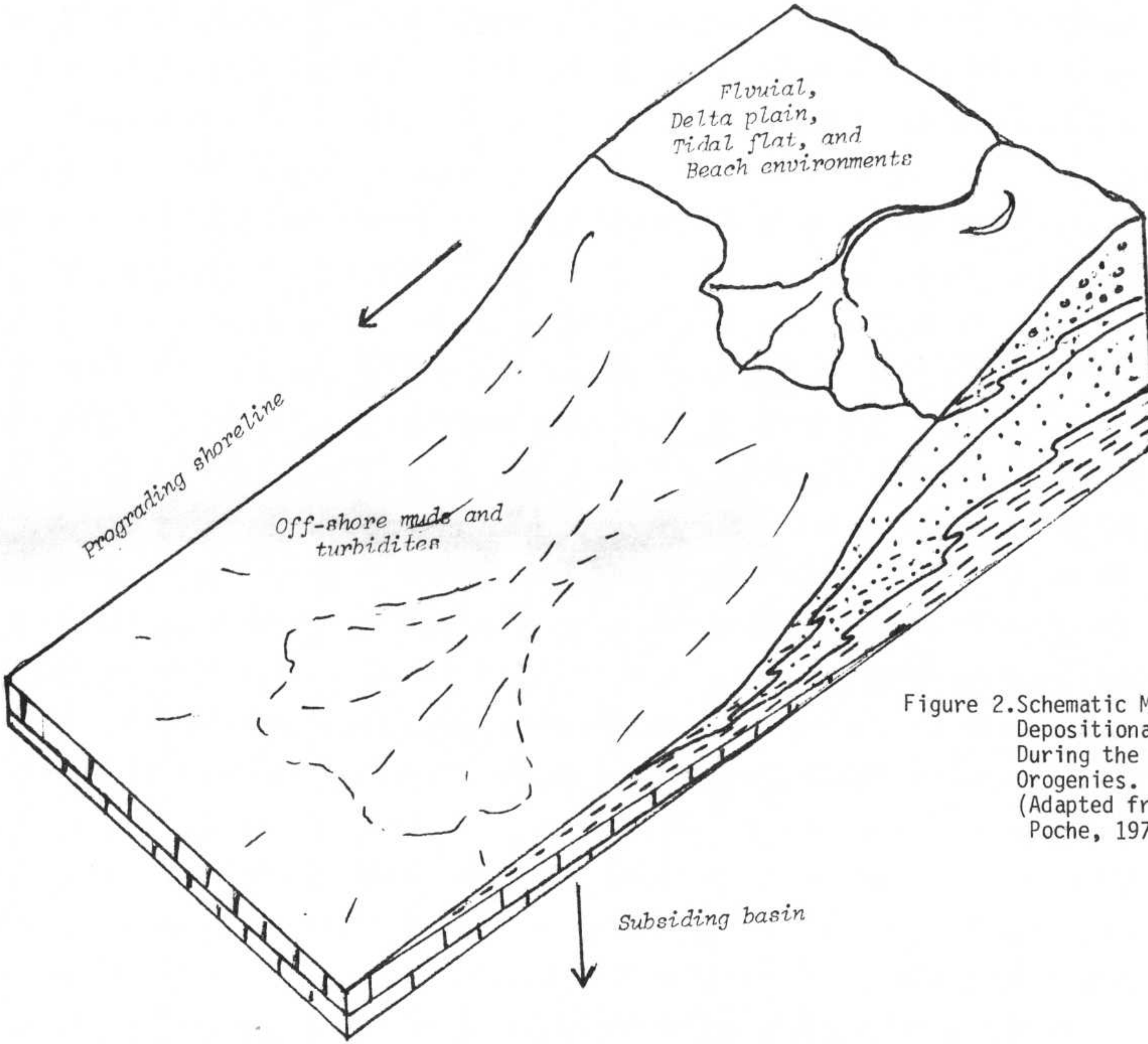


Figure 2. Schematic Model for Depositional Paleoenvironments During the Taconic and Acadian Orogenies. (Adapted from Fichter and Poche, 1979)

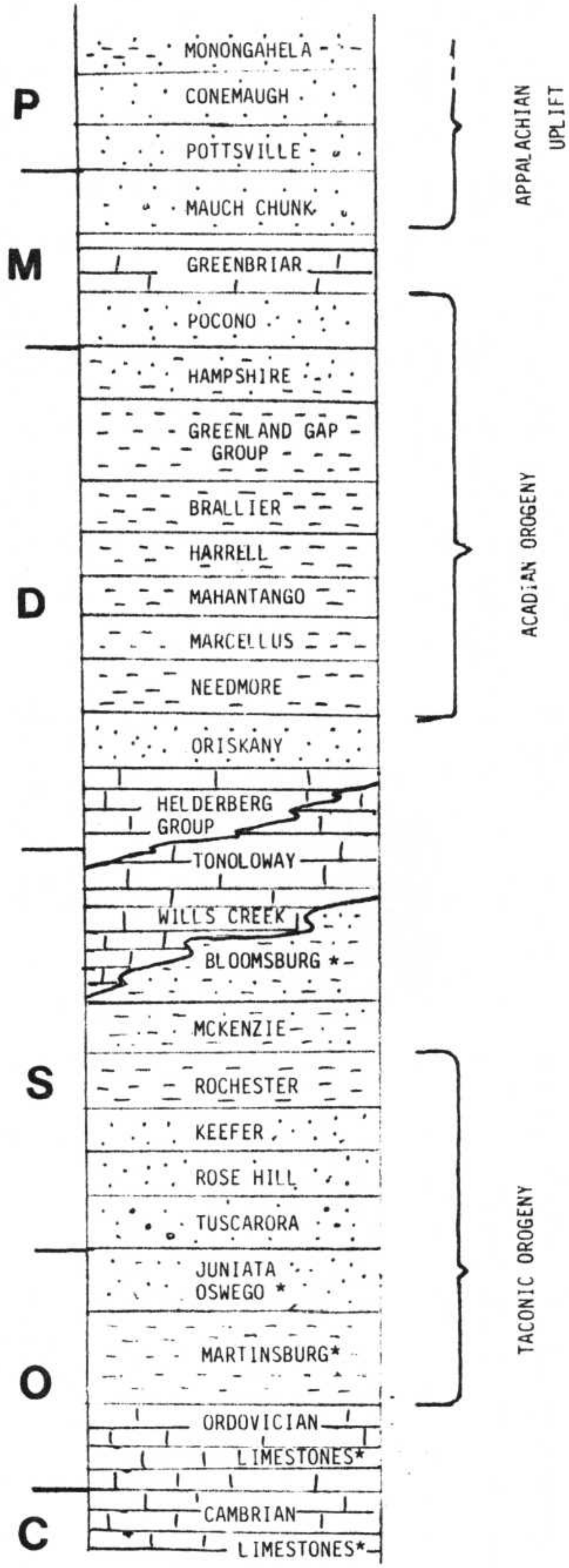


Figure 3. Summary of formations and tectonic events in this field trip area.

* Formation not seen on this field trip.

From Late Silurian through Early Devonian most of the basin once again became the site for carbonate deposition as sediment from the now aged Taconic highlands diminished and shallow water carbonate banks developed. Carbonate deposition ceased with the widespread deposition of clean quartz beach and off-shore sands (Oriskany).

The beginning of the Acadian orogeny is indicated by the widespread deposition of the Middle Devonian shales that form the major portion of the Devonian clastic wedge in Maryland and southwestern Pennsylvania. In this area the shales are conformably overlain by the coarser, red coastal and fluvial deposits of the Hampshire and non-red Pocono Formations. The latter marks a period of maximum regression in the Early Mississippian.

A brief return to carbonate deposition resulted from transgression during the relatively short period of tectonic stability in the northeastern basin margin in the Middle to Late Mississippian. Renewed tectonic activity as part of the Appalachian uplift once again produced a clastic sequence but without the deposition of large amounts of off-shore muds and turbidites. Instead there are red and gray alluvial deposits of regional regression intertonguing with minor shallow marine deposits.

During the Pennsylvanian emergent conditions allowed sedimentation in swampy, fluvial dominated deltaic plains which were from time-to-time inundated by brief regional transgressions. These fluvial-deltaic sequences contained peat deposits forming on delta plains and in back barrier environments, and thin limestones deposited in periods of submergence.

REFERENCES

Colton, G.W., 1970. The Appalachian Basin -- Its depositional sequences and their geological relationships. In Studies of Appalachian Geology: Central and Southern. G.W. Fisher, et al., eds., New York: John Wiley and Sons. p. 5-48.

Fichter, L.S. and Poche, D.J., 1979. Sedimentary paleoenvironments and Paleozoic evolution of the Appalachian geosyncline in the northern Shenandoah Valley. In Guidebook for Field Trips in Virginia. Richmond, Va.: Dept. of Education. p. 25-42.

Meckel, L.D., 1970. Paleozoic alluvial deposition in the Central Appalachians: A summary. In Studies of Appalachian Geology: Central and Southern. G.W. Fisher, et al., eds., New York: John Wiley and Sons. p. 49-61.

PALEOZOIC SEDIMENTARY ENVIRONMENTS ALONG THE ALLEGHENY FRONT

Henry G. Siegrist, Jr., University of Maryland, College Park

ROAD LOG

Mileage from start	
0.0	Midlothian Rd. at U.S. 48. Take U.S. 48 east toward Cumberland. Cross Georges Creek Basin. Note strip mining to the south.
1.9	MD Rte. 36 and U.S. 48. Outcrops of Pennsylvanian Monongahela (will be visited at Stop 6 on this field trip). Continue on U.S. 48 toward Cumberland proceeding down hill and down section across the Allegheny Front.
4.3	Outcrop of Mississippian Pocono Formation.
5.0	Outcrop of Upper Devonian Hampshire (Catskill) red sandstones and shales.
5.7	Outcrop of Upper Devonian Greenland Gap (Chemung) marine sandstones.
6.3	Exit 40, Vocke Rd. Leave U.S. 48. Turn left at traffic light to U.S. 40 Alt. (National Rd.) Turn right onto U.S. 40 Alt. at traffic light at Maryland State Police barracks. Follow U.S. 40 Alt. northeast as it parallels Wills Mt. (Haystack Mt.).
9.8	Intersection of U.S. 40 Alt. and MD Rte. 36. Turn right at traffic light into the Cumberland Narrows water gap following Wills Creek through the Wills Mountain anticline. The high cliffs visible on the north side of the gap are Silurian Tuscarora sandstone.
10.5	Pull into gas station parking lot on the right just before the bridge over Wills Creek. Leave bus and walk across bridge and onto Conrail property.

STOP 1. Cumberland Narrows: Ordovician Juniata and Silurian Tuscarora Sandstones

The "Narrows" cut through the Wills Creek anticline (Figure 1) by Wills Creek features the only good exposure of the Upper Ordovician (Ashgillian) Juniata Formation in Maryland. The contact with the overlying Lower Silurian Tuscarora Sandstone, the principal ridge former in this area, is gradational through

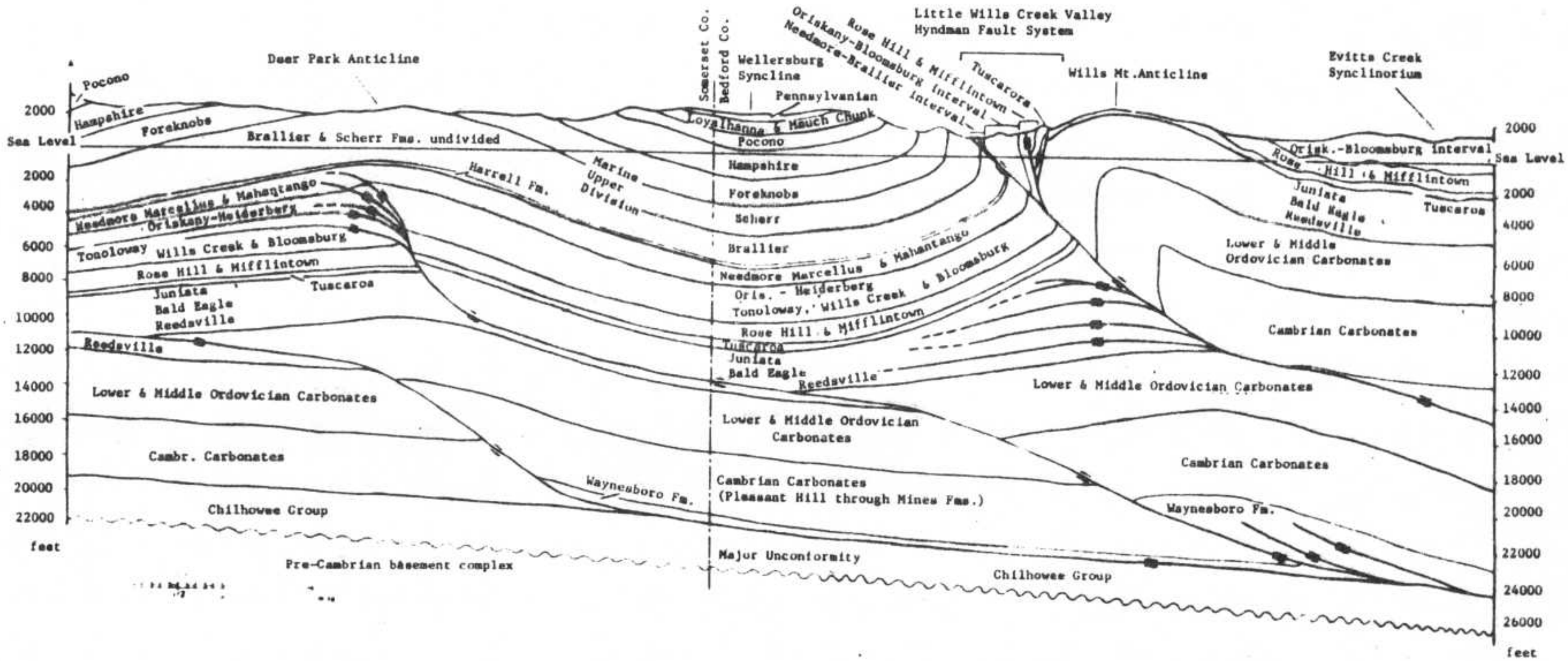


Figure 1. Cross section of the Alleheny Front near Hyndman, Pennsylvania. (Dennison, 1972)

a 30 meter zone of alternating red and white lithologies. The upper limit of the Juniata is placed arbitrarily at the highest dominantly red unit.

The continental red Juniata exposed here grades to the west in the subsurface into the mixed marine-continental carbonate sections of the Sequatchie Formation which in turn grades into the marine Richmond Formation in Ohio. The sandstones at the "Narrows" are predominantly lithicwacke (abundant rock fragments and matrix) with some of lithic arenite (less matrix) compositions. The modal composition given by the average of nine thin sections made from samples taken at this outcrop is:

monocrystalline quartz	41.2%
polycrystalline quartz	16.0
micaceous rock fragments	14.4
chlorite and illite	12.7
hematite	6.1
secondary silica	8.5
miscellaneous (carbonate, kaolinite, and zircon)	1.1

The detrital grains show pronounced orientation within the plane of bedding. Point-to-point and sutured grain contacts are pervasive among the monocrystalline quartz grains. Four diagenetic cements occur throughout the thin sections. Their overall paragenesis from oldest to youngest is: Hematite-illite-silica-chlorite, with perhaps a second stage of illite formation after the chlorite. Hematite occurs in pores and as inclusions between detrital host quartz grains and their overgrowths. Chlorite and early illite are seen as pore linings and a grain coatings.

The Juniata at the "Narrows" can be described as a prograding lower delta plain fluvial complex (Finachel, 1982). The mineralogy suggests a tectonically mature source area since there are no volcanic or plutonic rock fragments among the detrital grains. The progradation of Juniata detritus into the Martinsburg basin as the first influx of the Queenston tectonic wedge was probalbly interrupted by worldwide glaciation and regressive sea levels (Dennison, 1972). The resulting subaerial exposure of the Juniata overbank environments may have brought about oxidation of detrital ferromagnesian silicates or dehydration of detrital goethite to produce hematite. Subsequent burial under the prograding wedge of Tuscarora sands began the diagenetic processes that produced the authigenic mineralogy seen in thin section: secondary silica from pressure solution of quartz and illite formation; and formation of chlorite presumeably from the decomposition of earlier smectite clay minerals.

The railroad cut on the other side of Wills Creek exposes the eastern limb of the Wills Mt. anticline and contains an excellent set of outcrops which bracket the Tuscarora and overlying Rose Hill Shale contact zone.

End Stop 1.

Return through the "Narrows" to the intersection of U.S. 40 Alt. and MD Rte. 36

11.2 At intersection turn right (north) and follow Rte 36 parallel to the strike of Wills Mt. Note the large quarry in the Tuscarora on the northwest limb of the Wills Mt. anticline.

12.0 Abandoned quarries in the Lower Devonian Helderberg Limestone on west side of road. Dead ahead is a large working quarry in Siluria-Devonian carbonates.

12.5 Turn right into sand quarry and proceed past the office trailer east for about .75 mile on the quarry road.

STOP 2. Tuscarora Sandstone

This is an excellent dip slope exposure of the overturned western limb of the Wills Mt. anticline. The Tuscarora Sandstone seen here was deposited as a well-winnowed quartz sand. The sand may have originated from reworked Juniata or from newly exposed Taconic source areas and transported west and northwest on to the prograding Early Silurian coastal plain and shelf. East of here the Tuscarora and equivalent units are interpreted (Yeakel,1962; Smith, 1970; Cotter, 1983) as a braided fluvial system (Figure 2). In this area and in the subsurface further west the Tuscarora is believed to have been deposited as a series of beachstrand sands and offshore sand waves (Figures 2 and 3).

The accumulation of beach and shelf sands on top of the Juniata fluvial-delta plain complex requires a rise in the profile of equilibrium, i.e. a relative rise in sea level. Such a transgression would coincide with the glacioeustatic sea level rise following a Late Ordovician continental glaciation.

In this quarry, the Tuscarora sandstone is a medium- to coarse-grained, moderately well-sorted quartz arenite (orthoquartzite). Thin sections of several samples taken at random from here all show the rock to be made up of >85% monocrystalline quartz with secondary silica and carbonate cements making up the rest. In contrast to the Juniata, the lack of micaceous rock fragments and polycrystalline quartz (including chert) indicates a higher energy, wave dominated environment in the depositional basin.

Bedding thicknesses range from 10 to 85 cm with minor pebbly concentrations occasionally occuring along the bedding planes. Cross laminations of both planar and trough type are common. Shale partings and intraformational clay clasts can be seen. The latter especially so near the lower contact (with the Juniata) as at Stop 1. Both the Tuscarora and the Juniata lack body fossils. However, the trace fossil, Arthrophycus (a deposit feeder) is found in abundance on bed soles in this locality.

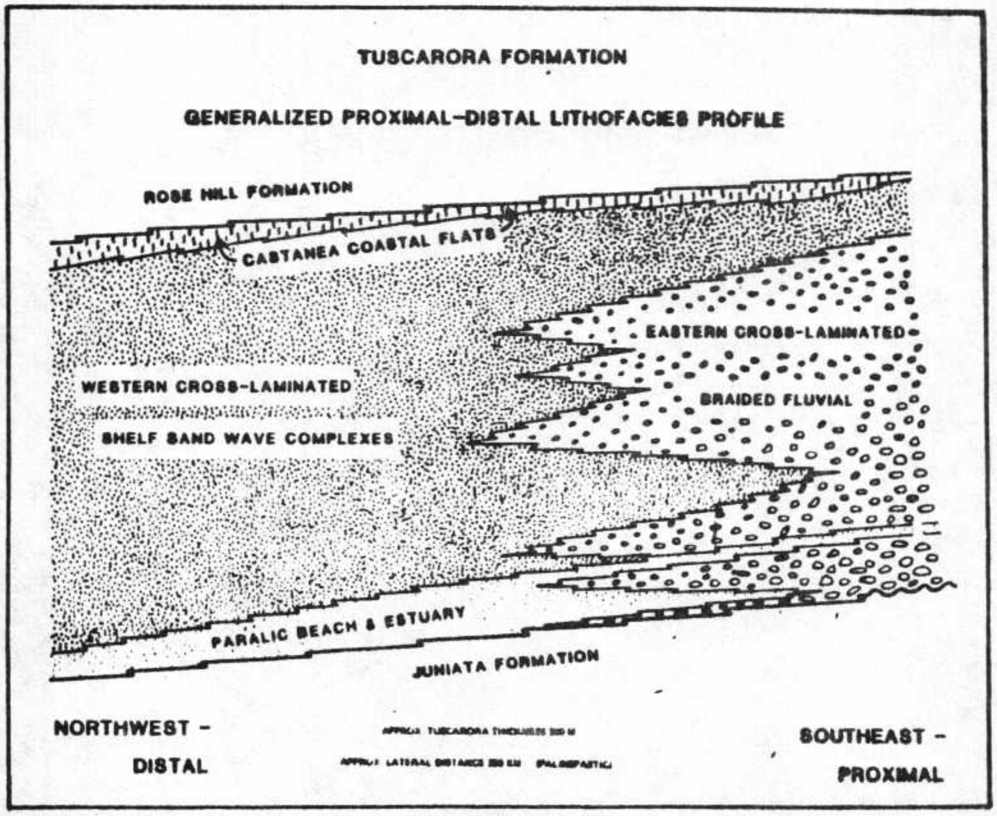


Figure 2. Tuscarora lithofacies profile (Cotter, 1983).

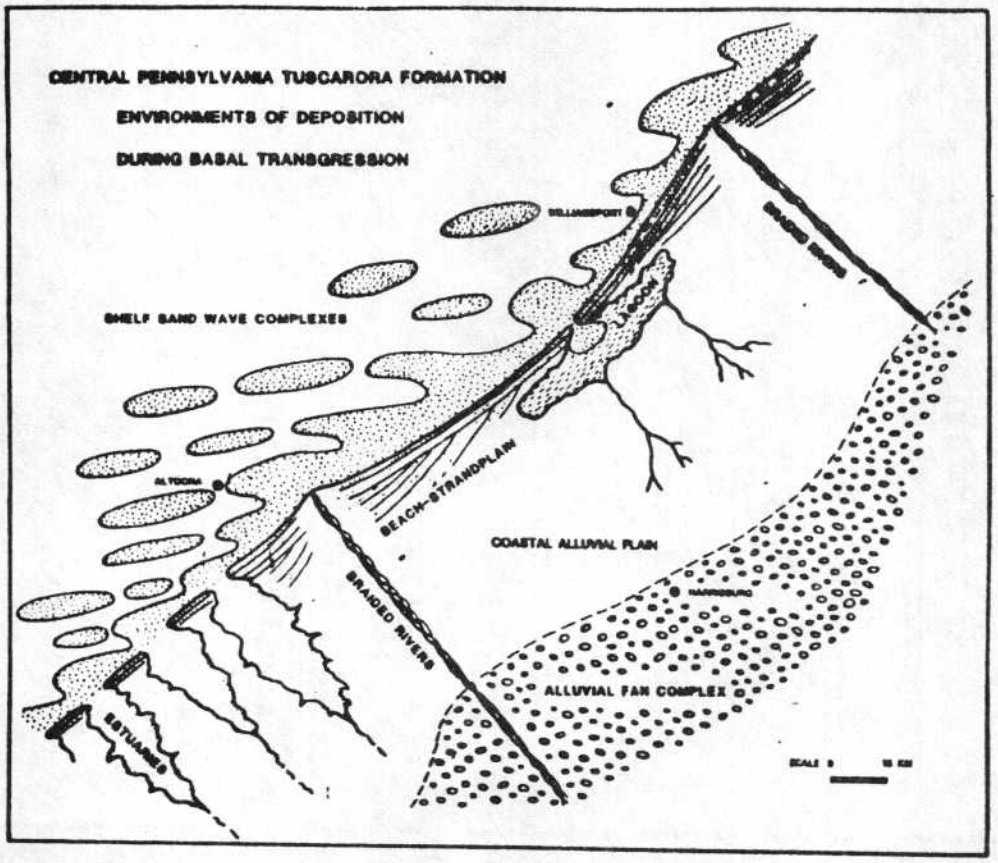


Figure 3. Reconstruction of Tuscarora paleoenvironments (Cotter, 1983).

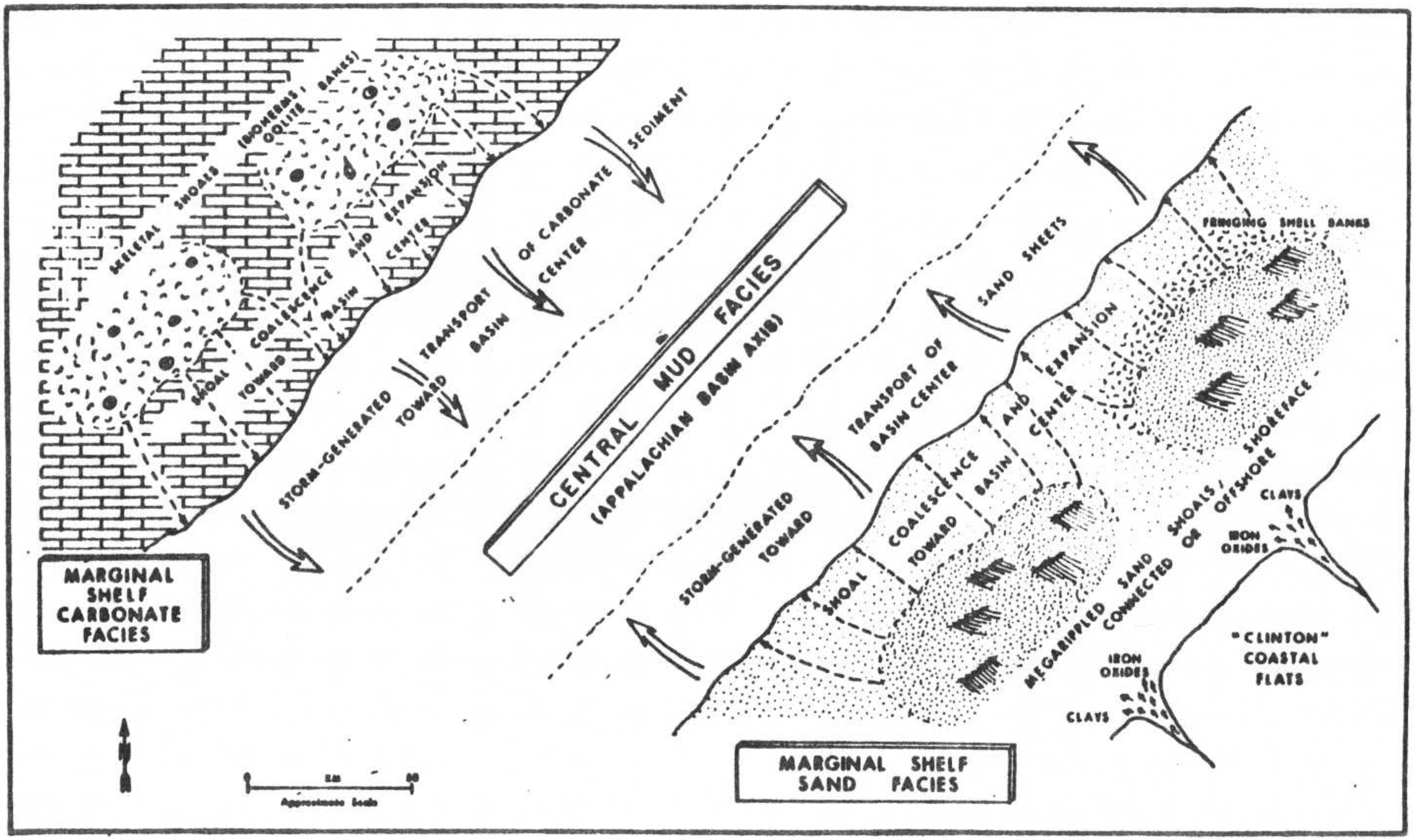


Figure 4. Conceptual model - Appalachian Basin Middle Silurian paleoenvironments. (Cotter, 1983)

End of Stop 2.

Return to MD Rte. 36 turn left toward U.S. 40 Alt.

13.9 Intersection of MD 36 and U.S. 40 Alt. Turn right at traffic light.

16.9 Intersection of U.S. 40 Alt. and Vocke Rd. Turn left at traffic light.

17.7 Intersection of Vocke Rd. and MD 53. Turn left at traffic light onto MD 53 (to U.S.220 South).

18.8 Large abandoned quarry in Keyser-Helderberg Limestone, on the left.
The road follows the strike of Wills Mt. which is rapidly loosing elevation in this direction.

19.8 Outcrops of Silurian Rose Hill Formation on the left.

20.1 Cresaptown. Proceed straight to U.S. 220 South.

20.4 U.S. 220. Turn right (south) at traffic light.
The Cresaptown Iron Member of the Rose Hill Formation crops out below the Methodist Church just past the turn.
Continue south on U.S. 220. Note Knobly Mt. on the left paralleling the Potomac River at its base.

22.0 Pinto Rd. at Pinto Mennonite Church. Turn left (southeast) onto Pinto Rd. Follow this road to the right to dead end.

22.5 Quarry on hill is in Lower Devonian Ridgeley Sandstone (Oriskany). Limekiln and Helderberg-Keyser Limestone outcrop along the hill on the left.

22.6 Leave bus. Walk through tunnel and up onto railroad track. We will walk to the far end of the outcrop.

STOP 3. Pinto Station. Lower Silurian - Lower Devonian Section

The railroad section at Pinto represents one of the finest continuous Silurian sections in this part of the country. The first, and still the most detailed, outcrop description was done by C.K. Swartz in 1923. More recently, the carbonate paleoenvironments indicated from this outcrop have been interpreted by Smosna and Warshauer (1979) using multivariate statistical analysis.

The section begins in the Rose Hill Formation of the Clinton Group on the east end of the outcrop and extends into the Keyser Limestone which crops out near the bridge at the village. In

general, the sequence points to the waning importance of the Taconic Highlands as a supplier of detritus and the transformation of the basin into shelf carbonate environments. The Middle Silurian (Rose Hill--Keefer--Rochester--McKenzie Formations) features a succession of thinly interbedded shales (mudrocks) and sandstones, often very calcareous, and coarsely crystalline limestones.

The Rose Hill consists mostly of grayish-green and chocolate-colored shales, and thin bedded lithic wackes and lithic arenites, many of which are ferrugenous. Very subordinate thin carbonates are also found within the Rose Hill sequence at Pinto.

A significant feature of the Rose Hill is the Cresaptown Iron Sandstone, a deep red to purple quartz arenite cemented with up to 50% hematite and 15% chamosite. This unit achieves a thickness of 8 meters at Pinto and continues at this thickness along the tracks for about 5 km. In Pennsylvania, the Rose Hill hematitic sandstones achieve thicknesses in excess of 30 meters.

The overlying Keefer sandstone at this location is a highly calcareous 2 meter thick interval of quartz arenite with some lenses of oolitic hematite. In turn, the Keefer is overlain by calcareous shales and muddy limestones of the Rochester and McKenzie Formations.

The Rose Hill contains few body fossils except for ostracods and Tentaculites and is interpreted by Folk (1960) and Cotter (1983) to be a shallow marine, siliclastic shelf mud deposit (Figure 4). Accumulation along the near-shore margin of the basin would allow storm waves in the shoaling areas off river mouths to concentrate or disperse sand, sandwaves, and shell banks. The Keefer lithologies built up episodically but were generally distal (further off-shore) to the Rose Hill muds. Wave action on the shallowing onshore slope could have provided the agitated environment required for the formation of the oolitic hematite/chamosite. Folk (1960) believes that the Keefer could have been deposited as an offshore barrier beach complex.

Cotter's model (1983) suggests that the Rochester and the McKenzie formed basinward and were derived from muds produced by carbonate banks further to the northeast. This interpretation is open to question, at least in part, because of the relationship of a red proximal deltaic facies in the McKenzie, the Rabble Run red beds of Washington County, MD. This unit obviously accumulated in an environment similar to that of the Juniata, i.e. lower delta plain brackish water to muddy marine.

The top of the McKenzie at Pinto is marked by the Bloomsburg interval, here named the Williamsport Sandstone, a well winnowed and finely rippled quartz arenite. Included within this 6-8 meter interval is a disintigrated thin-bedded limestone, shale and calcareous sandstone, the Cedar Cliff Limestone lentil. The entire package shows extensive bioturbation. Liperditia-rich beds are also common in the Cedar Cliff unit. The stratigraphic position and sedimentary structures imply that these units are the result of tidal mudflat-sandflat deposition where fauna are resticted to burrowing in-fauna and sporadic ostracod concentrations.

The Williamsport is followed by over 250 meters of Wills Creek and Tonoloway calcareous shales and limestones. The Wills Creek in Maryland is dominated by calcareous shales or argillaceous limestones in outcrop. Further to the west in Garrett County, subsurface Wills Creek (Cayugan) is entirely limestone. Still further west beyond Morgantown, West Virginia, the Wills Creek becomes dolomitic. This east-west trend is consistant along strike as far south as Roanoke, Virginia (Chen, 1977). The Tonoloway, however, is a carbonate unit throughout, but it also becomes dolomitic in central West Virginia.

The sequence of calcareous shale and thin-bedded, argillaceous limestone over the top of the Bloomsburg interval implies a shoreline retreat (transgression) eastward. Textural cyclicity, well developed algal mat structures, indications of high salinity, and dessication features point to low wave energy, sabkha deposition in which sediment deposition alternated between shallow subtidal and supratidal conditions.

The Tonoloway Formation is in many ways similar to the Wills Creek and is especially difficult to discriminate from the latter in weathered outcrops. The Tonoloway lithofacies represent a minor adjustment in the basin of deposition. The environments are predominantly shallow, subtidal and intertidal with fairly common dessication features. However, the lack of clay minerals indicates increased distance to terrigenous sources which implies continuing transgressive conditions. Tonoloway paleoenvironmental interpretations from Warshauer and Smosna (1977) and Smosna and Warshauer (1979) are presented in Figures 5, 6, and 7. These workers used cluster analyses of lithologic and community structure data to develop these interpretations.

Above the Tonoloway, limestone lithologies become obviously more thick-bedded, or massive. The overlying Keyser, separated from the Tonoloway by an erosional contact, is composed of medium-dark gray to medium gray, fine to coarsely crystalline detrital limestone with stromatoporoidal biostromes scattered through several horizons. Clastic grains of broken and whole shells are cemented by sparry calcite. Chert may be common. The middle part of the Keyser tends to be argillaceous. Massive Keyser beds weather to large, rubbly-surfaced boulders while thinner layers break into small nodular chunks. Common fossils include large stromatoporoids, bryzoan, corals, and brachiopods.

The lower Keyser (Lower Beyers Island Member) shown at Pinto represents an intertidal to a predominantly upper subtidal regime. Variably bedded, locally cherty and nodular, this unit displays burrowed and thin irregular seams of biosparite and dolomitic limestones.

Further south, in West Virginia, the Keyser represents a less restricted marine deposit. Still, at Pinto we can see the carbonate paleoenvironment changing throughout the Cayugan Stage, from the supratidal and intertidal tidal sabkha of the Wills Creek through the cyclic intertidal Tonoloway to the mostly subtidal Keyser.

If we were to walk out Pinto Road past the lime furnace toward route 220 we would see the remainder of the great

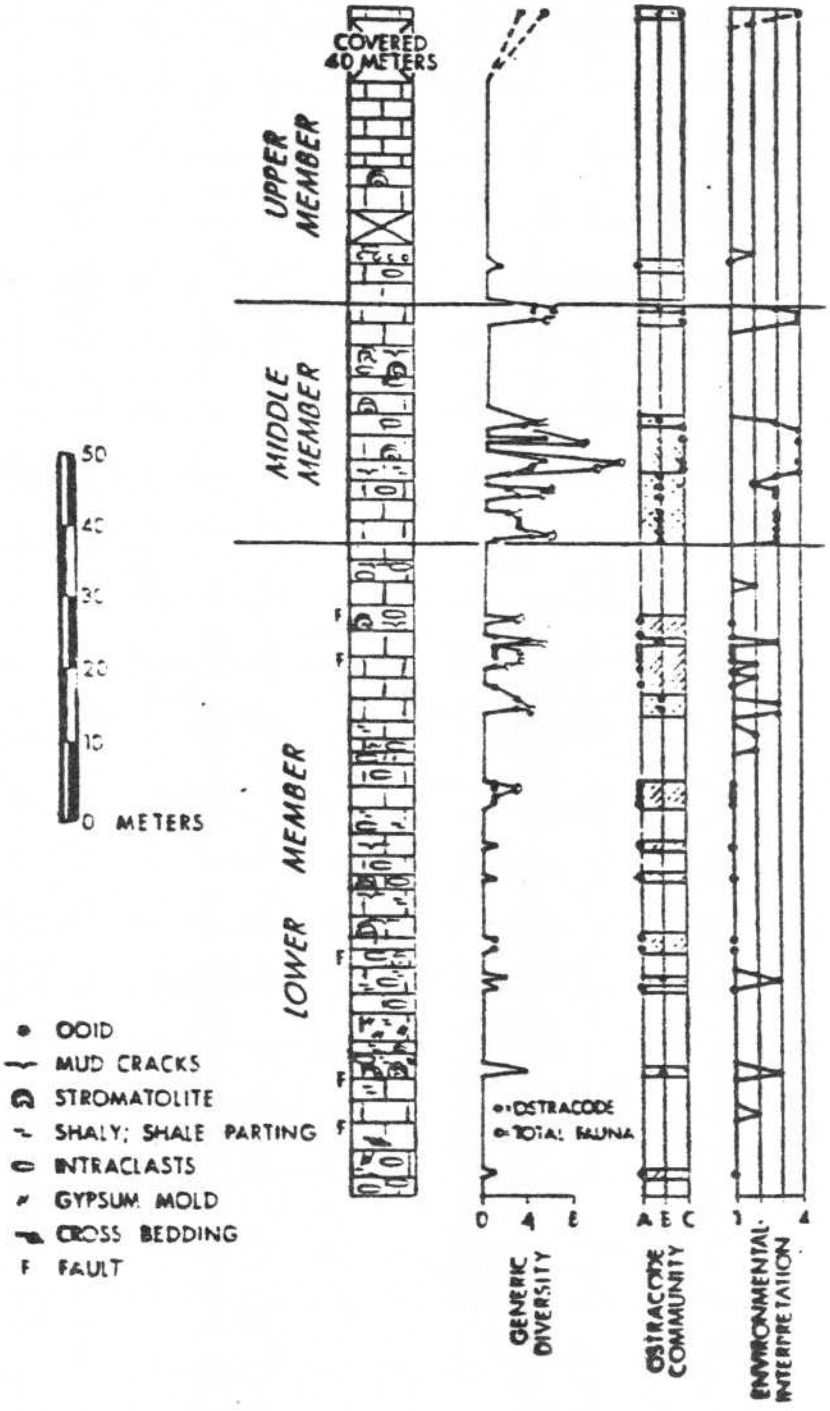


Figure 5. Diagrammatic stratigraphic section for the Tonoloway Limestone at Pinto. When the genetic diversity of the ostracodes equals the generic diversity of the total fauna, only the ostracode value is shown. Ostracode community A = Leperditia, B = Welleria-Dizygopleora, C = Zygobeyrichia-Holliella. Environmental interpretation 1 = intertidal mudflat, 2 = shallow subtidal, 4 = deepest subtidal . (Warshauer and Smosna, 1977)

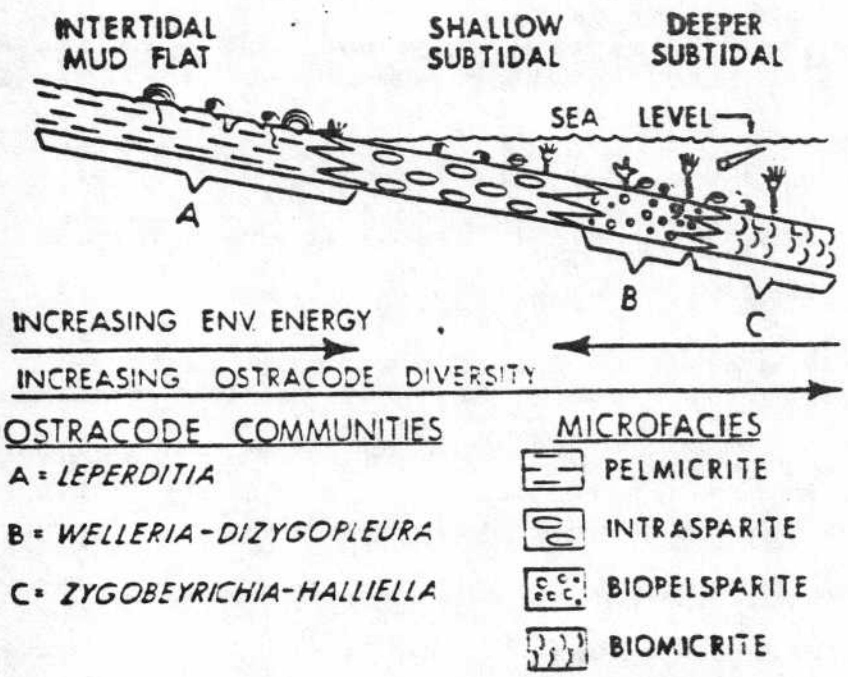


Figure 6. Diagrammatic interpretation of the lateral relationships of both the ostracode communities and carbonate microfacies. (Warshauer and Smosna, 1977)

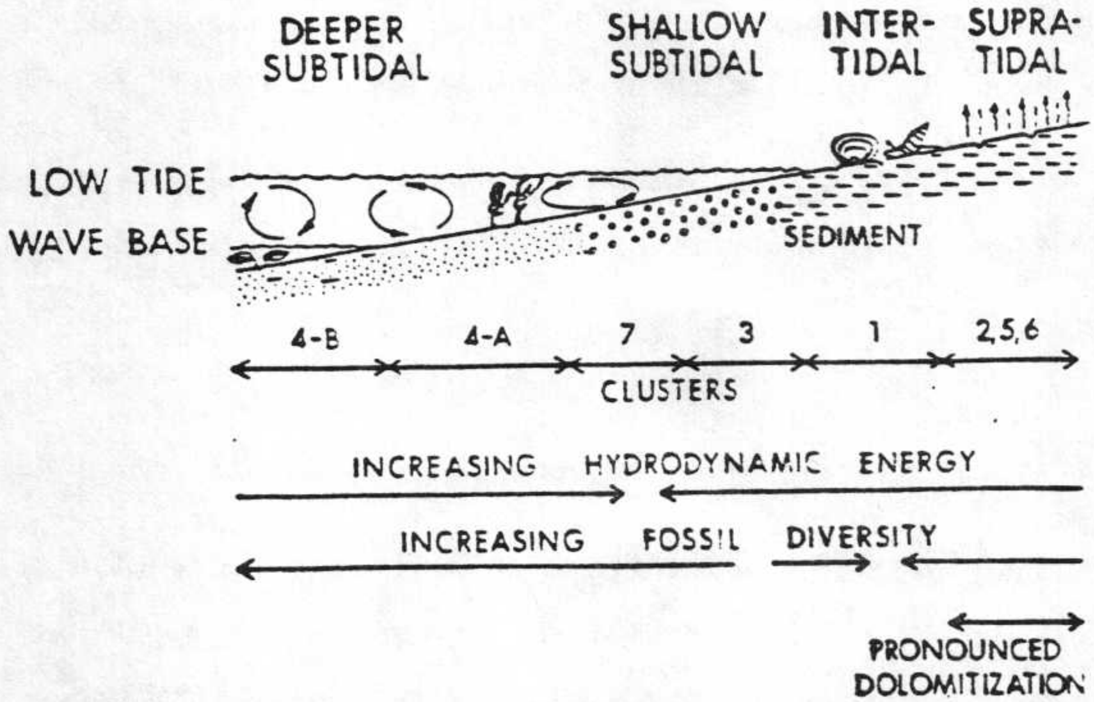


Figure 7. Diagrammatic interpretation of the Tonoloway paleoenvironments. Plotted at the bottom of the diagram are the relative locations of the Q-mode clusters and the inportant environmental gradients. (Smosna and Warshauer, 1979)

Silurian-Devonian carbonate section (Helderberg Group) which shows even deeper-water paleoenvironemnts. The slowly proceeding Niagaran-Cayugan transgression closes out with the deposition of the Ridgely Sandstone that can be seen in the small quarry to the north on the way back to route 220.

Return to U.S. 220 via Pinto Rd.

23.3 U.S. 220. Turn right (north) toward Cumberland.

24.9 Cresaptown Iron Member again.

Continue north on U.S. 220 through Cresaptown. Excellent outcrops along Knobly Mt. escarpment on the right.

26.3 Abandoned Celonese Plant entrance. Excellent McKenzie-Wills Creek Bloomsburg outcrops along the tracks (faulted anticlinal structure in Bloomsburg).

27.1 More Knobly Mt.

27.3 Outcrops of Keefer Sandstone along the west side of the road (left).

27.9 Red sandstones in the Rose Hill Formation crop out on the west side of the road.

28.1 Roberts Station. Rose Hill type section and excellent Rose Hill-McKenzie cut along railroad tracks.

28.5 U.S. 220 and 48. Turn east onto U.S. 48 toward Cumberland and proceed through Cumberland.

32.5 Harrell formation (Burket member) on right side of road (south).

32.9 Exit 47. Leave U.S. 48 make an immediate right past Ed Mason's Restaurant.
Right again (to U.S. 220,48,40).
Left to U.S. 220

33.3 Parking lot at carwash and Dairy Dip.

Lunch

STOP 4. Middle Devonian Mahantango Formation

We will use this outcrop to illustrate litholigies common in the lower part of the 2100 - 2900 meter thick Devonian Shale Sequence. In the area around Cumberland the Mahantango can be subdivided by two principal lithologies: a lower one of mostly shale and and overlying sequence of mudrock, siltstone and sandstone. All of these may be highly fossiliferous containing dense and abundant populations of brachipods, bryozoans, corals, pelecypods,

and crinoids.

The sands can be classified as subgraywakes (Pettijohn) or low-rank graywacke (Krynine); they lack the high percentage of labile rock fragments that typify the Upper Devonian sandstones, indicating that the Acadian Orogeny had not yet exposed plutonic source rocks. This writer, however, has found euhdral biotite (presumably volcanic) in Mahantango beds further east in Washington County.

Mahantango outcrops invariably display spheroidally weathered boulders -- up to 2.5 meters in diameter in new exposures near Sidling Hill in Washington County. These structures break down to regolith featuring slightly curved, prismoidal clumps. The Mahantango often is slightly calcareous and features abundant calcareous concretions. It weathers from an original medium gray or dark gray to various shades of olive brown to light ash gray. The Mahantango represents muddy sheet deposits with significant coarser influx associated with deltaic lobes. Its depositional environments could be compared with that of the Rose Hill seen earlier.

Note that thrust faulting has increased the exposed width of the Mahantango outcrop at this location. The ridge on the far side of route 220 is called Shriver Ridge and is held up by the formation of that name. Route 220 follows the Needmore-Marcellus valley north toward Bedford, PA.

The upper contact with the Harrell Shale can be seen about 0.5 km south of here on U.S. 48 (Optional Stop 4A). The Harrell at that site is the basal Burket Black Shale member which has a distinct depauperate fauna assemblage.

Return to U.S. 48 via U.S. 220, etc.

33.7 Take U.S. 48 west just past the cemetary on the left. Proceed through Cumberland and over Wills Mt. Note outcrops of Rose Hill and then Tuscarora on east side of the mountain.

Optional Stop 4A. Harrell Shale

40.0 Outcrop of Tuscarora on the west flank of the mountain.

40.8 Exit 40, Vocke Rd. Left off exit ramp onto Vocke Rd., to light at intersection with U.S. 40 Alt. Proceed across Rte. 40 into parking lot behind the Liberty Bank and MD State Police Barracks.

41.2 **STOP 5a. Middle Devonian Mahantango, Harrell, and Braillier, Formations and Greenland Gap Group.**

We will walk west behind the shopping strip to First United Bank and Trust across from Pizza Hut.

This section was previously measured by Swartz (1913) and redescribed and interpreted by Dennison (1972). It includes

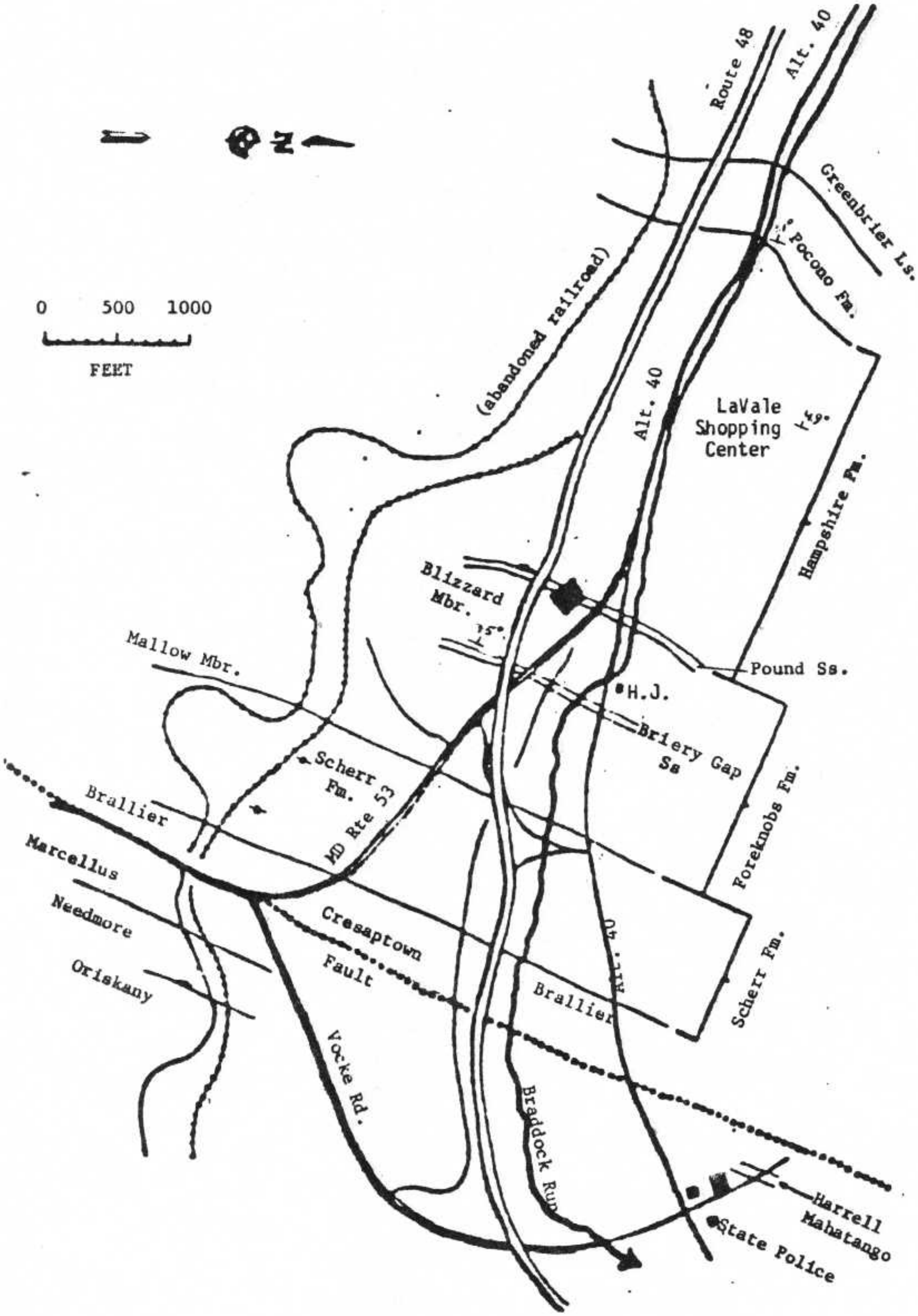


Figure 8. Map showing Devonian exposures in section at LaVale, MD. (Dennison, 1972)

almost 6000 feet of Devonian shale starting with upper most Mahantango exposed in the access raod cut and culminating in over 2000 feet of Hampshire redbeds. (Figure 8).

We will see textural and sedimentary structural evidence for a prograding prodeltaic sequence featuring a thick Braillier-Scherr interval followed by the Upper Devonian shallow marine shelf deposits of the Foreknobs Formation which, in turn, is overlain by marginal marine-nonmarine Hampshire beds.

Board bus. Proceed to LaVale shopping center via west on Rte. 40.

41.5 East end of LaVale Shopping Center.

STOP 5b. Hampshire Formation.

Pick up bus at west end of shopping center.
Leave shopping center on U.S. 40 Alt. west toward Frostburg.

45.3 Intersection U.S. 40 Alt. and MD 36. Turn left (south) on MD 36 to Hoffman Hollow Rd.

46.2 Hoffman Hollow Rd. Turn left (east).

46.6 **STOP 6. Pennsylvanian Monongahela Group**

Climb down embankment to U.S. 48 exit ramp and walk carefully down shoulder to outcrop.

The roadcuts on all sides of the intersection of Routes 36 and 48 were described by Falatko (1985) and interpreted by him to represent a lower delta plain - delta front environment. Falatko's stratigraphic section is shown in Figure 9. This particular outcrop is represented by about the 45 foot to 120 foot portion of this section. His interpretation was based partly on Donaldson's (1970,1974) shallow water delta models and on Harne, et al.(1979) petrographic and sedimentary structure criteria. Both constructional (progradational) and destructional (abandonment) phases of delta evolution are illustrated in these outcrops.

Return to MD 36.

47.0 Turn left onto MD 36 and almost immediately bear right on to U.S. 48 west.
Follow route 48 west, recrossing Georges Creek Basin, past Midlothian Rd.

50.6 Garrett County Line

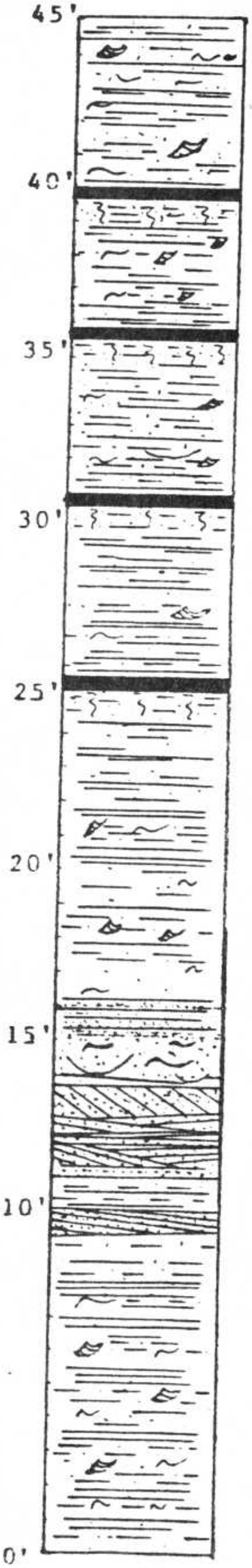


Figure 9. Stratigraphic Section -- Hampshire Formation
(from Falatako, 1985)

thin, 1/2-1"beds of rippled silt, shale splits and flasers, sharp contacts with shale

massive, siderite bands

silty shale, plant frags, rooted, siderite

mixed rippled silts/shale flasers, slight scour among coarser sediments

very thin beds1/32" plant frags, slight ripples among silts, fines upward

thin, 1/4"beds of silt/shale, rippled with shale flasers, plant stems, organics

mixed silty shale, organics, rooted

single thin bed1/2", rippled silts/shaleflaser
silty shale, fern leaves, organics

interbedded silts/shales, rippled siltstone with shale flasers, organic seams, 1/8"beds

1/8" planer beds with clay/organic partings
slight trough cross beds, low angle planer beds, and rippled towards top
low angle planer and trough cross beds, grades upward into rippled sands, shale splits

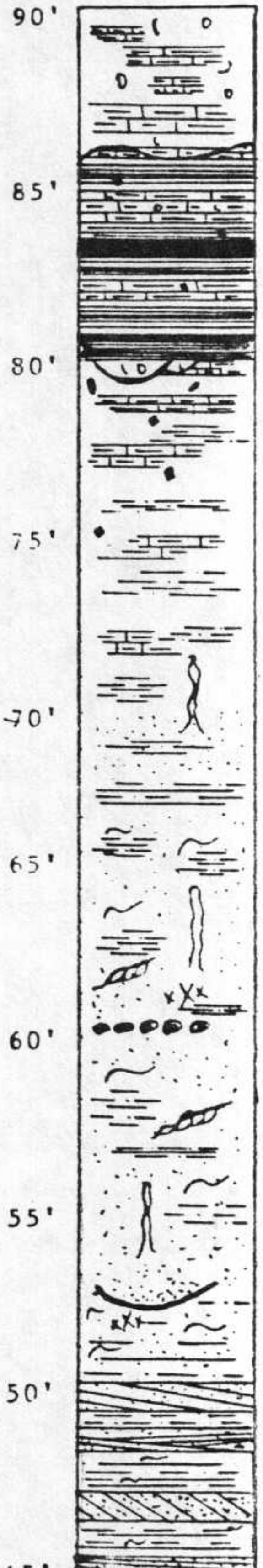
low angle planer cross beds, some ripples towards top, sharp contacts

thin1/4"beds, rippled siltston/shale flasers

planer beds, thin, plant stems

very thin planer beds, plant stems

Figure 9. Continued



micritic limestone, ostracods, lime intraclasts
argillaceous,plant fragmenta
micritic limestone, scoured at base,ostracods,
lime intraclasts,

shale and limestone, ostracod shell fragments,
organic rich

limestone fill, shale towards top,
scoured at base with fossil hash fill,
ostracods, and other shell fragments present,

dolomite
argillaceous limestone,silty at base,
irregular laminations, recrystalized, pyrite,
gradesupward into broken lime-mud with
calcareous noduals

siderite rich clastic dikes, ubiquitous
throughout this area

thin,1/4",gray,poorly sorted silty sands,
slight ripples, and thin beds of shale present
abundant siderite noduals

silt and shale, planer graded bedding,
siderite staining and calcareous matrix

thin1/4" beds, planer, mica splits,poorly sorted

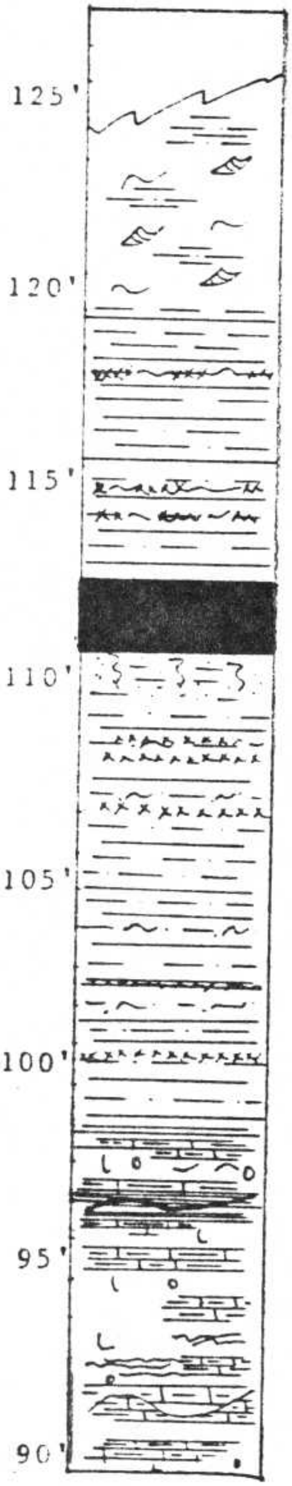
trough cross bedding, climbing ripples in silts,
micas, rock frags, siderite staining,
silts,micas,climbing cross bedded ripples,scour,

silty shale

low angle planer beds, shale contacts sharp
above and below, 3-6"thick sandstone beds
low angle planer sands,sharp contact with shales
above and below, multi-directional festoon beds

silty shale, graded bedding, micaceous

Figure 9 - continued



siltstone with shale flasers, thin 1/4"-1" beds, shale splits, sharp contact with below shale

silty shale, no apparent bedding, plant frags, fissility may indicate bedding

silty shale, small current marks in a siderite band preserved, pyrite, organics, shale on either side of band , sharp to gradational contacts

argillaceous limestone, abundant ostracods, fissile, organics, grades up into shale
lime, no ostracods, irregular organic laminae
lime, abundant ostracods, very argillaceous,
argillaceous limestone, ostracods,
argillaceous limestone, irregular laminations, no ostracods, pyrite, dolomite
argillaceous limestone, few ostracods decrease upward, pyrite, micritic to fine grained

51.4 Summit of Big Savage Mt. Beginning of a large outcrop of eastward dipping Pottsville Group and Mauch Chunk Formations.

52.8 Valley in the Mississippian Greenbrier Limestone.

52.9 Little Savage Mt.

53.0 Large eastward dipping Lower Pocono and Hampshire outcrop.

53.2 Exit on to MD 546. Turn left and proceed back onto U.S. 48 east.
From the ramp onto route 48 notice the Hampshire-Pocono contact on the far side of the highway.
(Stay-in-bus stop)

53.8 Top of Big Savage Mt.

STOP 7. Lower Pennsylvanian Pottsville Group

See Field Trip A , Stop 1 (p. , this guide book).

Return to Frostburg State College via U.S. 48 and Midlothian Rd.

BIBLIOGRAPHY

Chen, P.,1977. Lower Paleozoic stratigraphy, tectonics, paleogeography, and oil/gas possibilities in the Central Appalachians. Part 1. Stratigraphic Maps. Report of Investigations No. RE 26-1, West Virginia Geological and Economic Survey. Morgantown, WV.

Cotter, E.,1983. Silurian Depositional History. In Silurian and Devonian depositional history and Alleghenian deformation in the Pennsylvania Valley and Ridge. R.P. Nichelsen and E. Cotter eds. Guidebook, 48th Annual Field Conference of Pennsylvania Geologists. Bureau of Topographic and Geologic Survey, Department of Environmental Resources, Harrisburg, PA. p.3-40.

Dennison, J.M.,1972. ed. Stratigraphy, sedimentology, and structure of Silurian and Devonian rocks along the Allegheny Front in Bedford County, Pennyslvania; Allegany County, Maryland; and Mineral and Grant Counties, West Virginia. Guidebook, 37th Annual Field Conference of Pennylvania Geologists. Bureau of Topographic and Geological Survey, Department of Environmental Resources, Harrisburg, PA. 114p.

Donaldson, A., 1979. Geological factors affecting the thickness and quality of Upper Pennsylvanian coals. American Geological Institute, Guidebook Series, No. 1.

Falatko, D., 1984. Depositional environments in a Pennsylvanian outcrop near Frostburg, MD. Unpublished senior thesis. Geology Department, University of Maryland, College Park, MD. 45p.

Finachel, A.,1982. Markov chain approach to discriminate redbed depositional environments in Maryland. Unpublished senior thesis. Geology Department, University of Maryland, College Park, MD. 36p.

Folk, R.L., 1960. Petrography and origin of the Tuscarora, Rose of eastern West Virginia. Journ. Sed. Petrol. v.30,p.1-58.

Horne, J.C., Ferm,J.C., Caruccio, F. and Baganz, B., 1979. Depositional models in coal exploration in the Appalachian region. Am. Assoc. Petrol. Geol. Bulletin. v.62, no.12, p. .

Prosser and Swartz, C.K.,1913. The Upper Devonian deposits of Maryland. In Middle and Upper Devonian Text. Maryland Geological Survey, p.339-534.

Smith, N.D., 1968. Cyclic sedimentation in a Silurian intertidal sequence in eastern Pennsylvania. Journ. Sed. Petrol. v.38, no.4, p.1301-1304.

Smosna, R. and Warshauer, S.M., 1979. A scheme for multivariate analysis and carbonate petrology with an example from the Silurian Tonoloway Limestone. Journ. Se. Petrol., v.40, no.2, p.257-272.

Swartz, C.K.,1923. Stratigraphy and paleontological relations of the Silurian strata in Maryland. In Silurian Volume, Maryland Geological Survey, p.25-52.

Warshauer, S.M. and Smosna, R., 1977. Paleoecologic controls of the ostracod communities inthe Tonoloway Limestone (Silurian, Pridali) of the Central Applachians. In Aspects of Ecology and Zoogeography of Recent and Fossil Ostracoda. W. Junk, ed. The Hague. ???

Yeakel, L.S.,jr., 1962. Tuscorora, Juniata, and Bald Eagle paleocurrents and paleogeography in the Central Appalachians. Geol. Soc. Am. Bull. v.73, p.1515-1540.

PALEONTOLOGY AND PALEOECOLOGY OF SELECTED PALEOZOIC OUTCROPS IN SOUTHERN PENNSYLVANIA AND WESTERN MARYLAND

August H. Simonsen, The Pennsylvania State University, McKeesport, Pa.
Brian B. Tormey, The Pennsylvania State University, Altoona, Pa.

INTRODUCTION

This field trip will take us to outcrops in Lower Silurian, Upper Silurian to Lower Devonian, Upper Mississippian and Lower Pennsylvanian systems. The outcrops are located in the Appalachian Mountain Section of the Valley and Ridge Province and in the Allegheny Mountains Section of the Appalachian Plateaus Province. Prominent ridges of the Allegheny Mountains include Chestnut Ridge, Laurel Hill, Negro Mountain, and Allegheny Mountain progressing eastward. The J. V. Thompson Quarry (stop 1) is located on the Chestnut Ridge Anticline. The Maplehurst Farm (stop 2) and Mount Davis (stop 3) are located on Negro Mountain. The J. V. Thompson Quarry outcrop in Fayette County, Pennsylvania and the Keystone Lime Company mine outcrop on the Maplehurst Farm in Somerset County are composed of strata from the Mauch Chunk Formation.

STRATIGRAPHY OF THE MAUCH CHUNK FORMATION

The Mauch Chunk Formation (Upper Mississippian) is predominantly composed of interbedded shales (56%) and sandstones (36%) with minor amounts of limestone and siltstone. The Lower Mauch Chunk Formation in southwestern and southcentral Pennsylvania consists of the Deer Valley Limestone at the base, the Lower Mauch Chunk red clastics, and the Wymps Gap Limestone. The Upper Mauch Chunk Formation is composed entirely of clastic rocks, mostly shales and sandstones. The Wymps Gap and the Deer Valley limestones join with the Loyalhanna Limestone to form the Greenbrier Formation in the extreme southwestern corner of Pennsylvania. The Loyalhanna Formation is immediately below the Mauch Chunk Formation (Figure 1).

The fossiliferous Wymps Gap Limestone Member is a thin, marine tongue extending from the Greenbrier Group in West Virginia. It was known as the Greenbrier Limestone of Pennsylvania prior to 1965. It has been correlated with the Union Limestone of West Virginia. Faunal studies have indicated that the Wymps Gap Limestone is Chesterian.

At the Thompson Quarry the maximum thickness of the Wymps Gap Limestone is about thirty feet. The thickness of the Wymps Gap Limestone is about 40 feet at the type section locality at Wymps Gap, Pennsylvania, about 12 miles

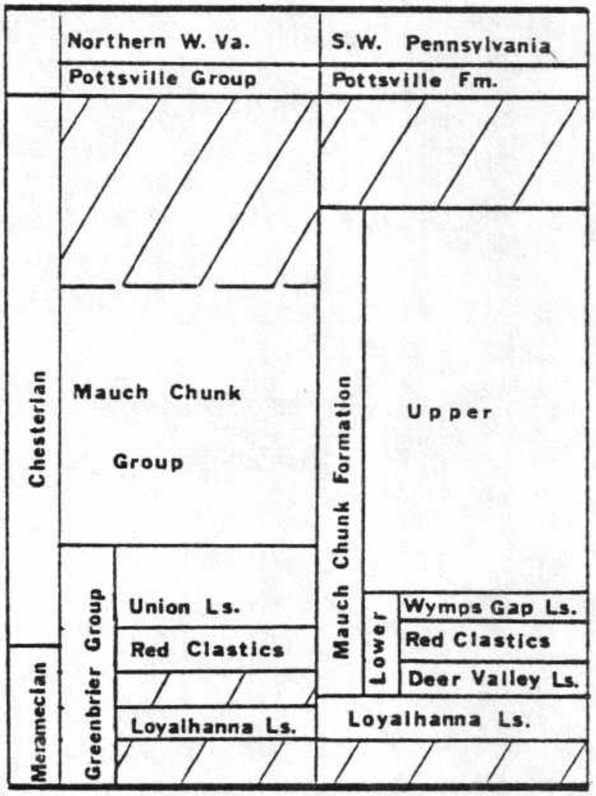


Figure 1. Correlation Chart for Northern West Virginia and Southwestern Pennsylvania based on Flint (1965), Busanus (1974) and Berg, et. al. (1983).

south of Uniontown, Pennsylvania. At the Keystone Lime Company mine the Wymps Gap Limestone is about 15 to 20 feet in thickness. The Wymps Gap thins to the north and the east, pinching out north of Pittsburgh, Pennsylvania, on the western side of Broad Top Mountain in Huntingdon County, and at the Bedford County - Fulton County border (Figure 2).

PALEONTOLOGY OF THE WYMPS GAP LIMESTONE

The Wymps Gap Limestone has brachiopods, bryozoans, crinoids, blastoids, echinoids, corals, cephalopods, pelecypods, gastropods, trilobites, ostracods, conodonts and foraminifera in its fauna.

Brachiopod genera indentified in the Wymps Gap Limestone include *Composita*, *Diaphragmus*, *Dictyoclostus*, *Dielasma*, *Orthotetes*, *Rhipidomella* and *Spirifer*. Simonsen identified several bryozoan species in an earlier study. They include *Fenestella tenax*, *Polypora corticosa*, *Septopora cestriensis*, *Sulcoretepora* cf. *nana*, *Rhombopora* aff. *lepidodendroides*, *Anisotrypa* cf. *solida*, *Tabulipora ramosa*, and *Prismopora*? sp.. Crinoid columnals, calyxes and ambulacara of the genus *Eupachycrinus* have been collected. Gastropod genera include *Bellerophon*, *Euomphalus*, *Naticopsis*, *Strobeus*, and *Worthenia*. Cephalopod genera observed in the Wymps Gap Limestone are *Michelinoceras* and *Endolobus*. Pelecypod genera are *Nuculopsis*, *Phestia*, *Pinna*, *Sanguinolites*, and *Wilkingia*. Other genera identified include *Kaskia* (*Paladin*), a trilobite; *Pentremites*, a blastoid; *Cavusgnathus*, *Gnathodus*, *Hibbardella*, *Hindeodella*, *Ligonodina*, *Magnnilaterella*, *Neoprioniodus*, and *Spathognathodus*, conodonts; and *Endothyra*, a foraminifer.

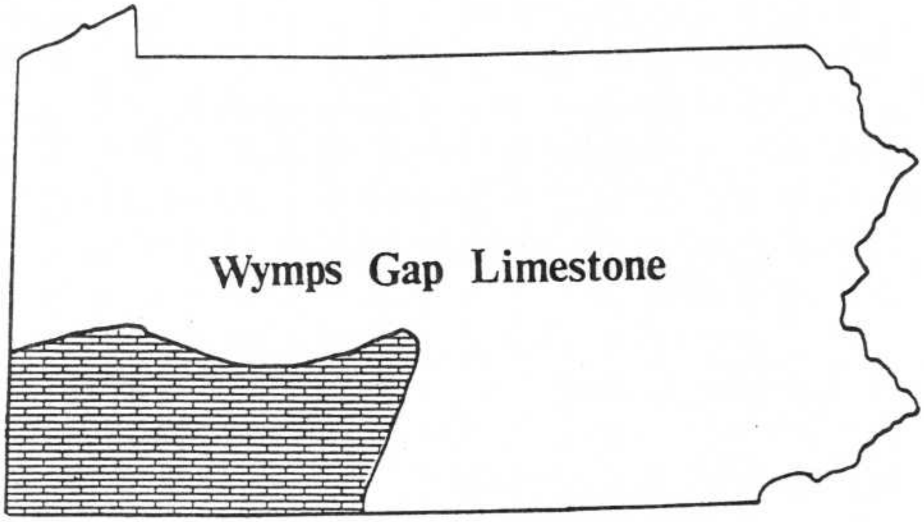


Figure 2. Paleogeography of the Upper Mississippian (Chesterian) Wymps Gap Limestone in Pennsylvania

PALEOECOLOGY OF THE WYMPS GAP LIMESTONE

The holistic approach to the identification of a fossil community attempts to get as close to the present counterparts as is possible with the data available. Taphonomic interpretations must be made as difficulties arise in identifying communities from post mortem (post-depositional) processes, such as diagenesis and biological and physical processes which may lead to the removal, mixing or alteration of the fossils. A natural ecologic association is a combination of species derived from a community which may have interacted at a low level. The life habit association is one of the natural ecologic associations which is based on having similar life habits, trophic levels, or behaviors.

The lithofacies observed in the Wymps Gap Limestone at the J. V. Thompson Quarry are massive, micritic limestones, fossiliferous shaly limestones, argillaceous coquinoid limestones and calcareous shales. Very thin calcareous shales are interbedded in some of the limestone units. Several natural ecologic associations were observed in the lithofacies described above. Fenestrate bryozoans (i.e. Fenestella, Polypora, and, less commonly Septopora), articulate brachiopods, and crinoids form a very common association observed in the argillaceous coquinoid limestones, shaly limestones and calcareous shales. Rhombopora Tabulipora and articulate brachiopods form an association found in the shaly limestone lithofacies. Other associations observed include a gastropod-brachiopod-crinoid association in massive limestones, and Composita-Orthotetes in the the shaly-limestone lithofacies.

Paleoecologic inferences may be drawn from observed life habit associations. Modern brachiopods are almost always stenohaline, epifaunal, sessile benthonic invertebrates. Seventy-one per cent of living brachiopods are found on the continental shelf. Living genera which first appeared in the Paleozoic Era are characteristically found only on the continental shelves, mainly occupying shallower depths (i.e. 30 feet or less). Living brachiopods may live in muddy waters, but are not successful in environments where mud and silt are actively being deposited. Some

Paleozoic brachiopods may have been able to survive in waters of stronger energy conditions due to the development of a cemented form of life. The quasi-infaunal strophomenid brachiopods (e.g. Orthotetes) were adapted for anchorage in soft substrates. Composita has been found to have been limited environmentally by salinity and sediment influx. Fossil brachiopods are most abundant in shallow water sediments.

Fenestrate bryozoans are believed to have favored carbonate mud bottoms which were relatively shallow (80-160 feet deep) and were under the influence of moderate to low energy water conditions. Sessile bryozoans cannot maintain themselves on eroding bottoms and lived below wave base. Fenestrates, as well as the ramose Rhombopora, and the encrusting Tabulipora, which are found in the fauna of the Wymps Gap, were found to have grown across and helped to stabilize muddy bottoms in the Permian Wreford Sea of Kansas. Normal to slightly-lower-than-normal salinities provide the most favorable conditions for the living marine bryozoans.

Living crinoids prefer shallow water and salinities between 24 and 36 parts per thousand. Marine pelecypods and gastropods prefer normal marine, shallow water environments. The life habit associations most often observed in the Wymps Gap Limestone lithofacies include bryozoans, brachiopods, and/or crinoids. In the argillaceous coquinoid limestone, shaly limestone, and calcareous shale lithofacies the diversity of fossils observed in many rock samples appears to represent a mature community.

Present day carbonate depositional environments are usually warm, clear and shallow marine located in low latitudes. Clear water suggests that the sourceland is low, distant, and/or stable. Autochthonous factors, within the basin of deposition, such as energy conditions of the water, shape of the basin and light conditions in the water control the development of carbonate facies. Primarily, carbonate deposits are formed biochemically. A strong correlation exists between lithofacies and biofacies. For example, substrates exert control on the fauna which can inhabit them. Most of the carbonate particles are deposited at the site of formation. In the analysis of textural materials, such as grains and matrix, it appears the presence of lime mud offers more accurate information on energy conditions of the water than do grains. Most often finer sediments appear to be deposited in deeper waters offshore and in calm areas behind barriers.

Data from paleomagnetic and paleobotanical studies along with the carbonate facies found in the Wymps Gap Limestone support the conclusion that the paleolatitude of the Late Mississippian (Chesterian) sea was about 10 degrees south. Lithofacies and biofacies reveal that the Wymps Gap Limestone was formed in a northeast trending arm of a carbonate platform which covered vast areas in West Virginia, Kentucky and other states to the west and south of Pennsylvania. The marine setting was offshore, away from the margin of the platform, and usually below the wave base. Some rock specimens contained whole, or nearly whole, specimens of brachiopods (e.g. Orthotetes, Composita, Spirifer, Dictyoclostus), large fragments of fenestrate bryozoan fronds (e.g. Polypora and Fenstella), large fragments of Rhombopora and Tabulipora zoaria, pygidia of Paladin, shells of pelecypods, mainly Wilkingia and Pinna, the gastropods Worthenia and Euomphalus, and long crinoid columnals (some with diameters of 18 mm). Other rock specimens contained a fossil hash, hundreds of small fossil fragments, which may indicate either higher energy conditions, episodes of higher energy conditions associated with storms or currents, or post depositional changes.

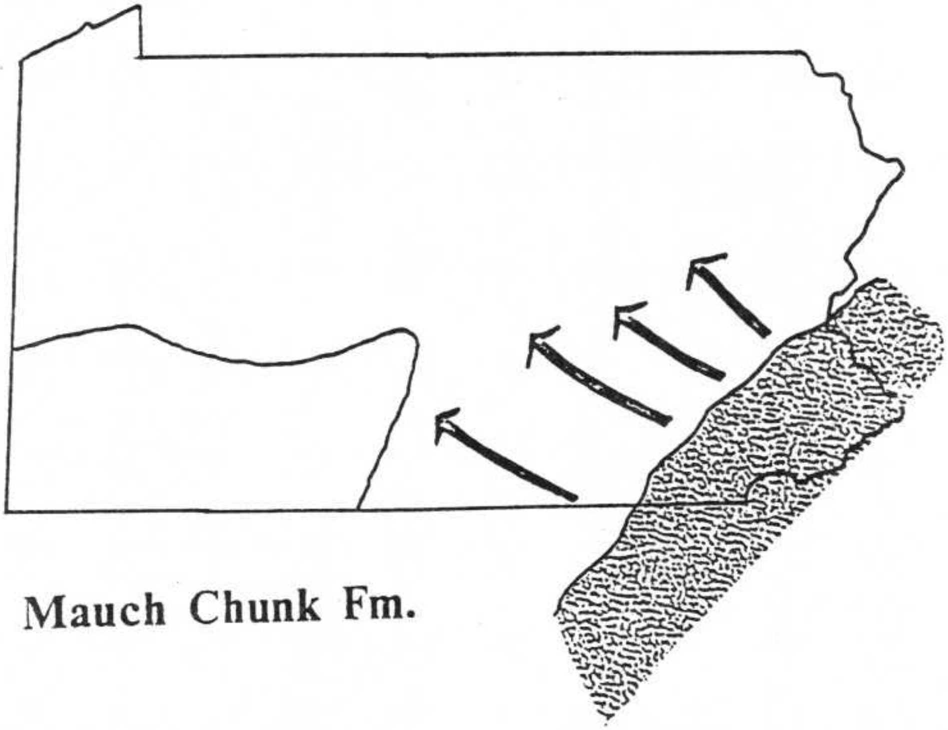


Figure 3. Primary Source of the Red Clastic Deposits in the Mauch Chunk Formation in Pennsylvania

The Mauch Chunk Formation and the Loyalhanna Formation provide us with further understanding about the Late Mississippian environments in southern Pennsylvania. The Loyalhanna limestone is an arenaceous calcarenite predominantly, but does occur as a calcareous sandstone in its upper section. These lithofacies may represent the change of environment from marine to continental. The sand constituents were derived most likely from sandstone and other rocks which were formed earlier in the Paleozoic Era. The presence of sand, lime, and oolites indicates that the paleoenvironment may have been a beach, dune, sand bar, or channel in areas of waves and currents associated with a transgressive sea.

The Deer Valley Limestone in the Lower Mauch Chunk Formation is a calcarenite composed of approximately 36% calcite grains, 33% detrital microfossils, and 26% microcrystalline cement and the remainder quartz grains. Outcrops of the Deer Valley in Somerset County shower a higher per cent of quartz grains and the presence of ooolites. These data suggest a high energy paleoenvironment along a beach, sand bar or channel.

The Lower Mauch Chunk red clastics intertongue with the Deer Valley and Wymps Gap Limestones. The Appalachian Basin most likely was receiving large amounts of clastic sediments as the sea regressed. Deposition exceeded the rate of subsidence. The primary source of the clastic deposits was an orogenic source in southeastern Pennsylvania, eastern Maryland and Virginia (Fig. 3). These deposits are believed to be the upper red bed facies of the Acadian Wedge. The red clastics include grayish red shale and siltstone, and yellowish gray sandstone which are believed to form from sediments deposited on flood plains, tidal mud flats, and in prograding deltas.

The sea in which the Wymps Gap Limestone was formed transgressed northeastward as the rate of subsidence increased to become greater than the rate of sedimentation. Intertonguing between marine carbonates and clastics has been observed. The red clastics thin westward with an upward fining of the average grain size and the maximum grain size representing a lowering of the competence of streams. Studies of the crossbedding have revealed paleocurrents which flowed westward to northwestward predominantly.

The Upper Mauch Chunk clastics are part of the lower red bed facies of the Appalachian Wedge associated with orogenic activities at the plate margins of North America and Africa.

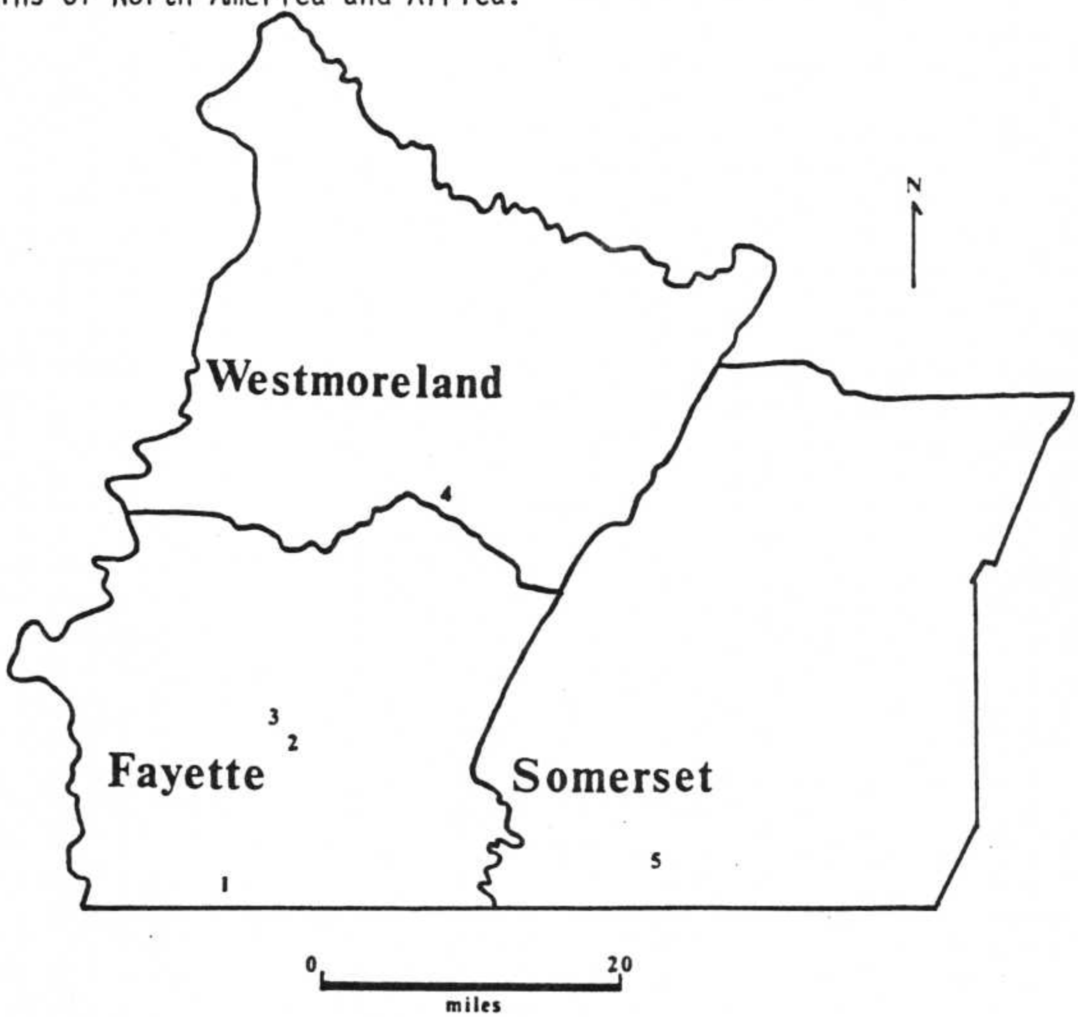


Figure 4. Locations of Outcrops of the Wymps Gap Limestone
1 = type section locality, 2 = J. V. Thompson Quarry,
3 = Jumonville, 4 = Pennsylvania Turnpike, 5 = Maplehurst Farm

ROAD LOG - FIELD TRIP C

MILES	ROUTE DESCRIPTION
0.0	Starting Point - Entrance to Frostburg State College, Frostburg, Maryland. Proceed to U. S. Route 48 west.
6.3	Big Savage Mountain - 2800 feet
10.6	The eastern CONTINENTAL DIVIDE
20.5	Negro Mountain in the Allegheny Mountains
22.5	Keysers Ridge Exit - Proceed to U. S. Route 40 west.
25.7	Maryland - Pennsylvania border
26.2	The NATIONAL ROAD (U. S. Route 40) The National Road was fathered by Albert Gallatin and was begun in 1811 at Cumberland, Maryland. It was completed to Wheeling, West Virginia in 1818. It was a toll road under state control from 1835 to 1905.
26.4	Winding Ridge Summit - 2601 feet
30.9	Youghiogheny River Dam Rock units exposed are beds in the Conemaugh Group (Pennsylvanian) - Upper Glenshaw and Lower Casselman Formations.
42.4	FORT NECESSITY Fort Necessity was erected in 1754 by and English colonial expeditionary force under Major George Washington in Great Meadows. An attack by French and Indians led to its surrender July 3, 1754.
43.5	BRADDOCK'S GRAVE General Edward Braddock led an expedition against Fort Duquesne (Pittsburgh) in 1755. Surprised by French and Indians his force was defeated. He died of wounds suffered in the battle.
47.1	STOP NUMBER 1 - J. V. Thompson Quarry near Chalk Hill, Pennsylvania. This quarry is on the eastern flank of the Chestnut Ridge Anticline and is in the Wymps Gap Limestone Member of the Mauch Chunk Formation. The quarry is currently being used as Pennsylvania Department of Transportation storage area. It was a very active quarry in the early part of the century producing road aggregate materials and lime.

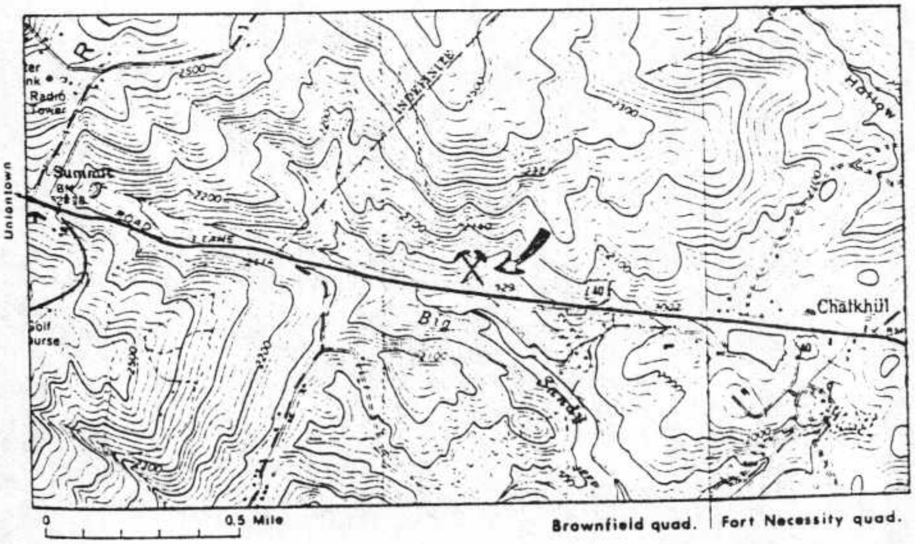


Figure 5. Location Map of the J. V. Thompson Quarry - STOP 1
(Courtesy of the Pennsylvania Geological Survey)

Fossil collecting is possible at all sites in the quarry and from the float and weathered sediments. Fine sediments and soils should be collected for later examination under the microscope for microfossils, such as foraminfera and conodonts. Wet sieving the sediments using standard sized sieves (425, 850 and 1000 micrometers) will expose many of the microfauna.

Hickok and Moyer (1940) published data about the thicknesses of the various units in the Wymps Gap Limestone Member which outcrop in the J. V. Thompson Quarry. The data are the following:

	FT.	IN.
surface clay passing downward into green shale	3	6
massive bed of hard limestone	1	8
greenish, fossiliferous shale with thin streaks of limestone	2	0
thick-bedded limestone	4	0
dark colored shale	1	6
thick-bedded limestone	22	0
argillaceous limestone	0	6

The calcareous shales, argillaceous coquinoid limestones and some of the shaly limestones may be disaggregated using Quaternary-O releasing their fossils.

The Wymps Gap Limestone at this quarry strikes northeast and dips to the southeast.

The gastropod-brachiopod-crinoid association has been collected primarily from units composing the floor of the quarry midway along the south margin. Rhombopora-Tabulipora-articulate brachiopod association has been collected from the western most side of the quarry.

Beneath the Deer Valley Limestone is the Loyalhanna Limestone, which is a greyish red, crossbedded formation measuring about 40 feet thick. Its red color comes from interstitial hematite and hematite coatings. It is used as road aggregate and as railroad ballast. It has one of the highest coefficients of friction for crushed stone. The Wymps Gap Limestone is mined for agricultural lime during the winter months.

76.8 STOP NUMBER 2 - Maplehurst Farm Quarry in the Wymps Gap Limestone. DO NOT ENTER THE MINE AT THIS OUTCROP.

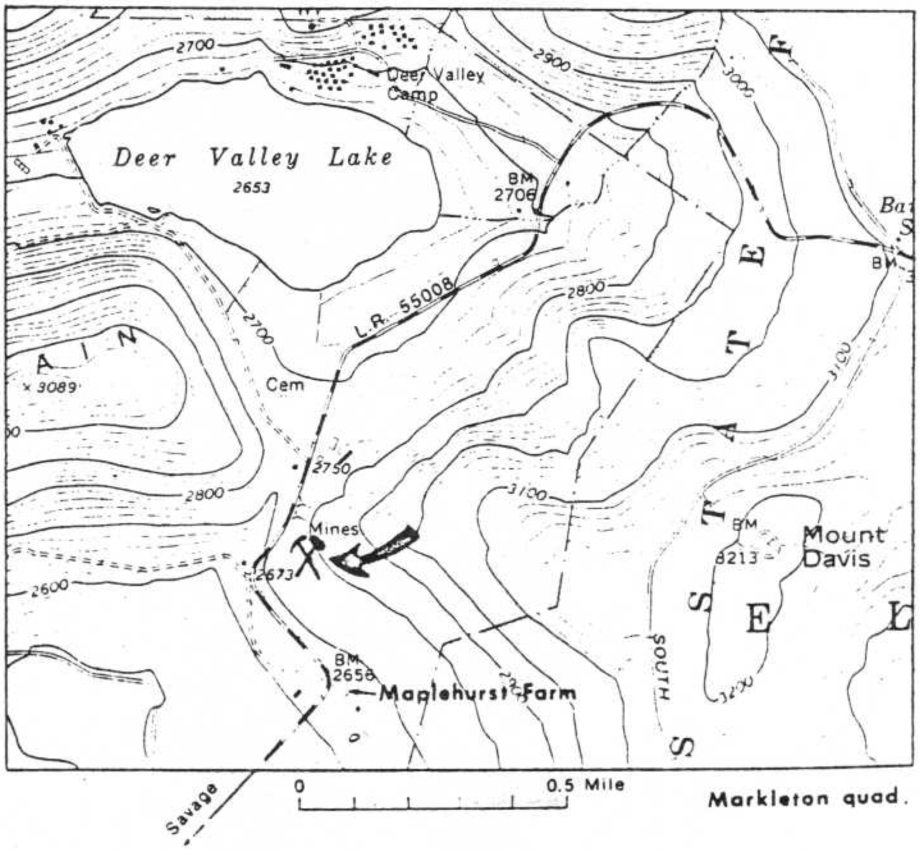
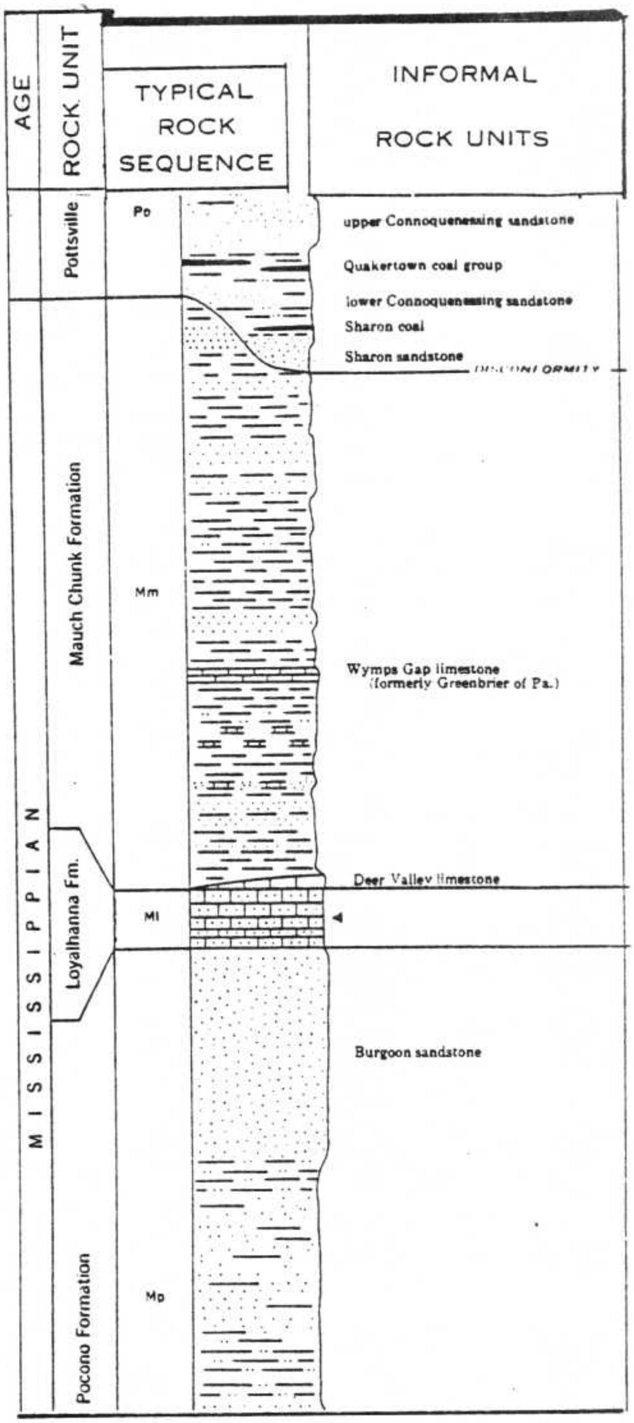


Figure 6. Location Map of the Maplehurst Farm Quarry and Mount Davis. (Courtesy of the Pennsylvania Geological Survey)

Figure 7. Generalized Stratigraphic Column of the Upper Missis sippian System in South- western Pennsylvania. (Courtesy of the Pa. Geological Survey)



Proceed east on U. S. Route 40.

66.6 Turn left on to Pennsylvania Route 523.

68.2 Listonburg, Pennsylvania
Turn right on to Legislative Route 55008.

75.6 Mount Savage, Pennsylvania
The Keystone Lime Company has two quarries and one underground mine that provide road aggregate materials and agricultural lime. The Deer Valley Limestone is quarried for agricultural limestone.

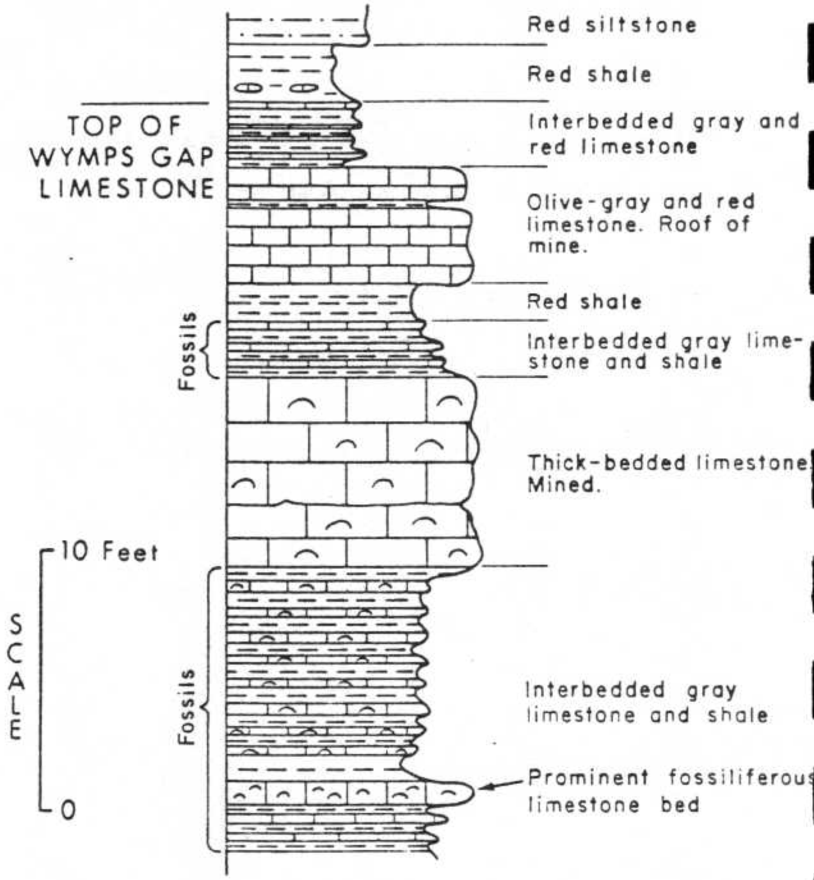


Figure 8. Generalized Section of the Wymps Gap Limestone at the Maplehurst Farm Quarry. (Courtesy Pa. Geol. Survey)

Proceed on Legislative Route 55008

78.6 STOP NUMBER 3 - Mount Davis
Mount Davis is 3213 feet above sea level and is the highest point in Pennsylvania. The erosion resistant sandstone exposed is from the Pottsville Group (Lower Pennsylvanian). The Pottsville Group occurs about 450 feet stratigraphically above the Wymps Gap Limestone Member of the Mauch Chunk Formation.

The forty foot high tower permits us to view Negro Mountain and the Allegheny Mountain Section of the Appalachian Plateaus Province.

Turn right on to Legislative Route 55008.

83.6 Turn left on to Summit Mills Road.

84.8 Summit Mills, Pennsylvania

88.1 Meyersdale, Pennsylvania
Turn left (north) on to U. S. Route 219.

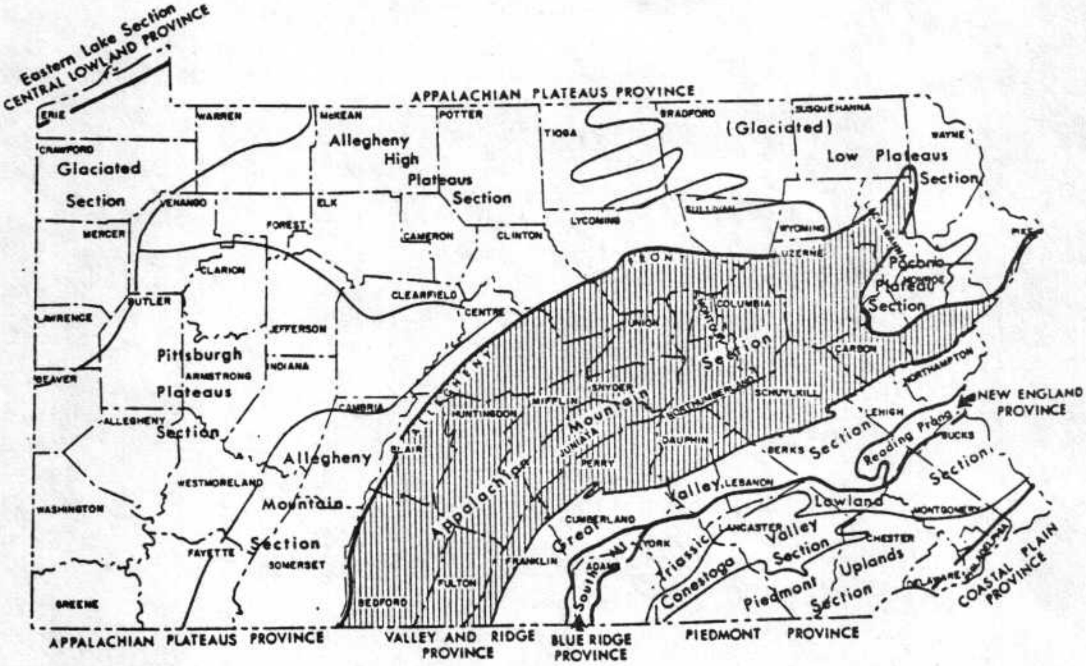


Figure 9. Physiographic Provinces of Pennsylvania
(Courtesy of the Pennsylvania Geological Survey)

91.6	Garrett, Pennsylvania
99.3	Berlin, Pennsylvania
107.9	Somerset, Pennsylvania Left on to Pennsylvania Route 31.
108.5	Turn right (north) on to U. S. Route 219.
108.8	Enter the Pennsylvania Turnpike and proceed east toward Bedford, Pennsylvania.
121.1	Allegheny Mountain Tunnel The strata are in the Allegheny Group (Pennsylvanian System) on the western side of the tunnel. On the eastern side of the tunnel the Burgoon Sandstone of the Pocono Formation (Mississippian System) is exposed. Most of the tunnel is Mauch Chunk shales.
143.3	Exit at the Bedford, Pennsylvania Interchange from the Pennsylvania Turnpike. Turn left at the exit.

146.1 Turn left (north) onto Pennsylvania Route 56 and Business U.S. Route 220 ("old U.S. 220").

147.0 Dunnings Creek Bridge.

147.6 Turn right (east) on the second paved road, LR 05100, before the U.S. 220 4-lane overpass. This road follows along Oppenheimer Run. Proceed on LR 05100.

148.5 STOP NUMBER 4 - Rose Hill Formation, "fossil-ore" in Bedford County, PA. Access to the "gravel pit" indicated on the location map may be made along a farm lane on the left (north) side of LR 05100. Contrary to the reference in Hoskins, et al. (1983), Mr. F.L. Hoagland is <u>not</u> the property owner at this site.

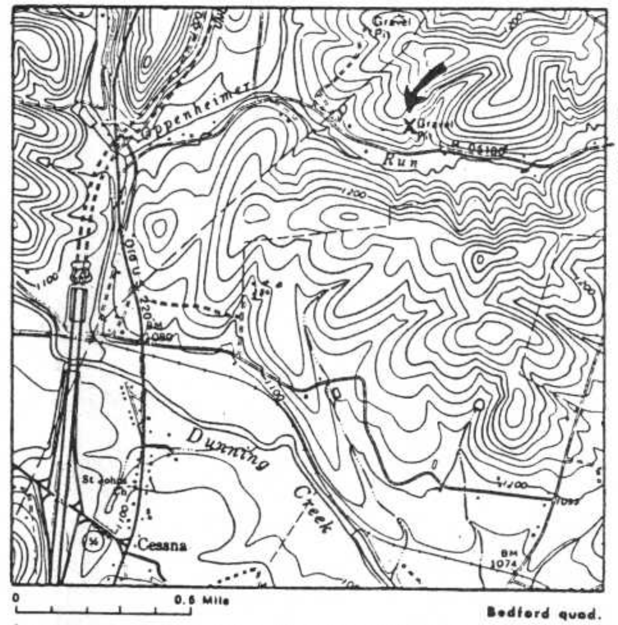


Figure 10. Location Map of Stop Number 4.

(Courtesy of the Pennsylvania Geological Survey)

Lower Silurian age fossils, mostly brachiopods may be collected at this site. Many specimens may be picked up in the loose float, the exposed surfaces of the "ore"-bearing rock, and the overlying shales exposed in the cut bank on the left side of the lane extending up the hill. Abundant fossils may also be found on spoil piles on the right side of the lane as well. Near the top of the hill on the right, a larger spoil pile includes many large chunks of the fossiliferous coarse facies.

The hematitic and chamositic skeletal grainstones represent one of three major periods of iron

mineralization in the Silurian of central Pennsylvania, when sea level lowered and agitated marginal shoals expanded toward the Appalachian Basin center.

149.4 Return back to the intersection of LR 05100 and Business (old) U.S. Route 220. Turn left (south) toward Bedford proceeding on "old" U.S. Route 220.

150.5 Turn right (west) on Pennsylvania Route 56 and proceed under the overpass of Interstate U.S. Route 220 (4-lane).

150.8 Turn left (south) onto the entrance ramp of Interstate U.S. 220 (4-lane).

156.0 Old Bedford Village (on left), a 72 acre pioneer village, where men and women practicing the traditional crafts of the region, provide visitors with a living history lesson. The village is open daily 9-5 PM April through October.

157.0 U.S. Route 220 narrows to two lanes.

157.8 Keyser and Tonoloway Formations on the left (east) side of U.S. Route 220 form the west slope of Evitts Mountain. U.S. Route 220 approximately follows the upper contact of the Wills Creek Formation, which floors the Cumberland Valley southward. The northeastward plunging Wills Mountain anticline forms the ridge capped by Silurian Tuscarora Sandstone on the right.

162.8 Texas Eastern pipeline pump station.

170.7 Centerville.

175.3 STOP NUMBER 5 - Photo stop. Silurian Williamsport Sandstone is exposed in the low roadcut on the right (west) side of U.S. Route 220. The Williamsport Sandstone is the nonred lateral equivalent of the Moyer Ridge Member of the Bloomsburg Formation in central Pennsylvania Hoskins (1961). Upon reexamination of the Bloomsburg-Williamsport at this and other outcrops near the Pennsylvania - Maryland border, Hoskins (1972) revised his earlier contention "that the sediments were deposited sub aqueously and not exposed to air." Near Bedford, almost all the Bloomsburg red beds have been replaced by grey shales and limestones (Mifflintown and Wills Creek Formations).

The Williamsport Sandstone exposed here was described by Hoskins (1972) as follows:

		Feet	Inches
5.	Sandstone, olive gray, very weathered and extermely porous; some sand grains up to 3/8 inch in long dimensions		2
4.	Claystone, olive gray, shaly, partially covered	5	
3.	Sandstone, very fine grained, and siltstone, grayish red and olive gray, bedding surfaces with mudcracks; few traces of bedding remain due to extensive bioturbation from many worm burrows up to 1/8 inch in diameter. Contains discontinuous lenses up to 3 inches thick of laminated, crossbedded, quartzose sandstone; some lenses are apparently fine-grained, cleaner, sand in-fillings of ripples; upper layers contain clasts up to 1 inch diameter of lithology similar to surrounding material.	4	
2.	Siltstone to very fine-grained sandstone, olive gray; highly bioturbated with extensive worm burrows of two types: a small tube approximately 1/16 inch in diameter and less common burrows of <u>Arthrophycus</u>.	7	
1.	Claystone, shaly, olive gray, silty	5	
	Exposed	21	2

Approximately one mile north of this site bedding planes of the upper units reveal mudcracks superimposed on a ripple-marked surface.

180.3 Mason - Dixon Line. Pennsylvania - Maryland boundary line.

180.5 Washington's Road. ("Old," old Route 220) Washington opened the road from Cumberland to Bedford. By order of Col. Bouquet, George Washington's troops opened this road from Fort Cumberland to Reas - town (Bedford, PA) during July 1758. Bouquet and Washington conferred half-way between these places July 30, 1758.

183.9 Left turn continuing on U.S. Route 220 (south).

184.3 Right turn onto U.S. Route 40 (west).

185.7 Cumberland, Maryland city limits.

186.1 Exit U.S. Route 40 (Exit 44) Willow Brook Road.

186.2 Turn right on alternate U.S. Route 40 (Baltimore Ave.)

186.9 Turn right on U.S. Route 40 alternate (Henderson Ave.), west along the railroad tracks (on the left).

187.8 Railroad trestle bridge. Water gap of Wills Creek through Wills Mountain is visable ahead.

188.0 Flood protection wall for Wills Creek was built by the U.S. Army Corps of Engineers. The active portion of the Chesapeake and Ohio Canal was in Cumberland near the confluence of Wills Creek and the North Branch of the Potomac River. Barges ceased activity about 1924.

188.2 Cross Wills Creek. On the left, Tuscarora Sandstone is exposed with redbeds of the Juniata Formation exposed in the railroad cuts on the right.

188.4 Wills Creek Water Gap. "The Narrows," is one of the most picturesque spots around Cumberland. It was discovered by Spendelow, after the road over Wills Mountain had been constructed by General Braddock. It was adopted as the route of the Cumberland Road (the National Road) in 1833. The old Stone Bridge across Wills Creek was used from 1834 to 1932.

188.6 Crest of Wills Mountain anticline formed by arch of Tuscarora Sandstone.

189.0 Tuscarora Sandstone dipping steeply on the southwest end of Wills Mountain anticline.

189.1 Turn right onto Maryland Route 36 toward Corriganville.

189.7 STOP NUMBER 6 - The Corriganville Quarry is reputed to be one of the finest continuous exposures of the upper Silurian and lower Devonian in Western Maryland. Unfortunately, portions of the section are unaccessable, due to steep slopes and overhangs left by quarrying (especially the middle and upper Keyser Formation). The quarry and nearby outcrops expose the near vertical beds of the Silurian upper Tonoloway Limestone, the Silurian and Devonian Keyser Limestone and the Devonian New Creek and Corriganville Limestones, Mandata Shale, Schriver chert and parts of the Oriskany Sandstone.

The sketch on the following page shows a columnar section and a sketch of outcrop locations of interest in the quarry. The following description from Dennison et. al. (1972) may be used to guide your observations.

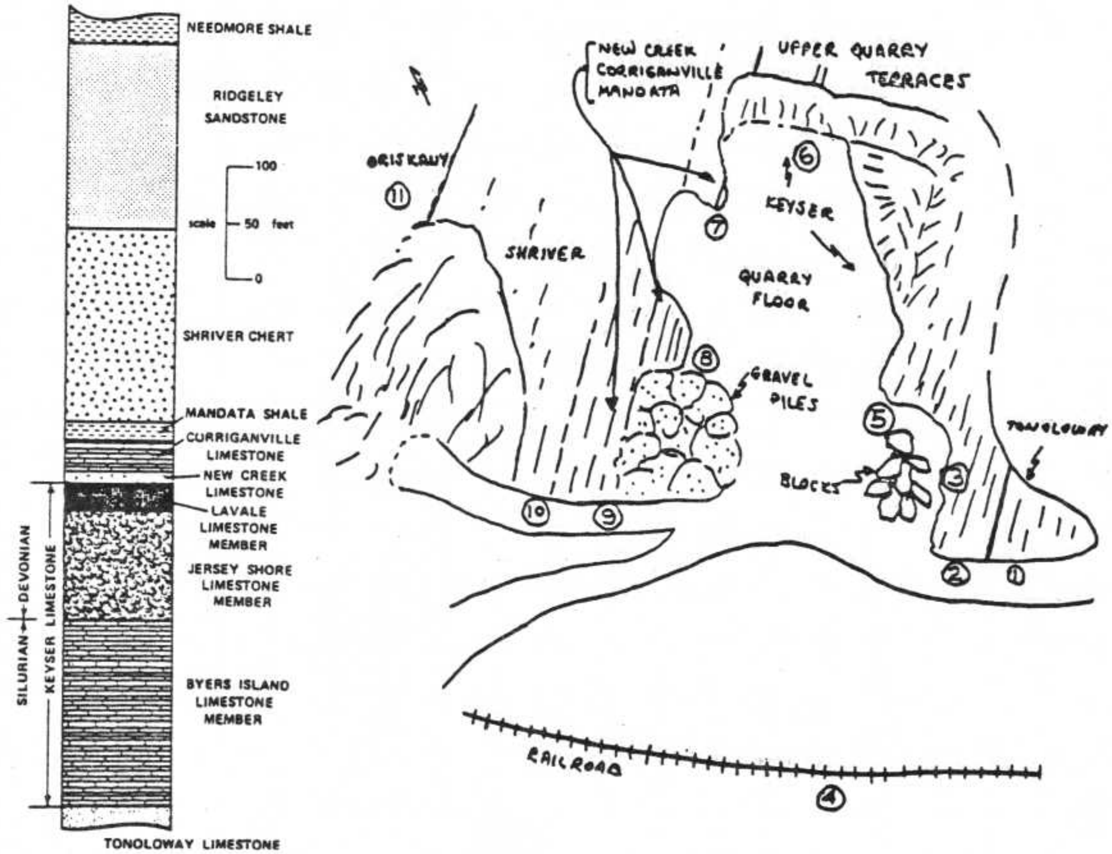


Figure 11.
Geologic Column and Formation Locations in the Corriganville Quarry Section (modified from Dennison et al. 1972)

1) Tonoloway Limestone (Silurian) - Thin-bedded to laminated generally unfossiliferous limestone and dolomitic limestone. Represents supratidal to shallow subtidal facies existing just prior to the more normal marine Keyser environments. Contact with the overlying Keyser is often erosional.

2) Keyser Limestone (Lower Byers Island Member; Silurian) - Variably bedded, locally cherty, somewhat nodular lime muds, silts, and sands. Burrowed; thin, laterally irregular interbeds of fossil hash; some dolomitic limestone. These lower beds represent dominantly intertidal and shallow subtidal environments. To the northeast along the outcrop belt as one travels toward the western basin margin, more restricted environments dominate this part of the section. To the south (as at the type section at Keyser) more normal marine environments are seen in this stratigraphic position.

3) Keyser Limestone (Middle Byers Island Member; Silurian) - Abundant stromatoporoids and favositid corals occur in the quarry wall in this area in subtidal carbonate environments.

4) Lower Keyser - Approximately 90 feet of lower Keyser and uppermost Tonoloway are exposed along the railroad tracks just south of the dirt and gravel pile.

5) Keyser Limestone (Upper Byers Island Member - Lowermost Jersey Shore Member; Silurian and Devonian) - A variety of limestone types ranging from massive to thin-bedded and shaly; lime sands and silts often interbedded; some chert. Brachiopods are locally abundant; in particular, the Gypidula prognostica peak zone appears within this interval. Subtidal carbonate sand environments tend to dominate this part of the section. Elsewhere in the depositional basin during this time interval the regional transgression was establishing distinctly subtidal environments in central Pennsylvania and New York.

6) Keyser Limestone (LaVale Limestone Member) - Thin to medium bedded, often laminated and mudcracked stromatoporoid-rich limestones are exposed in mostly inaccessible outcrops in the far quarry wall. The fauna is generally restricted to stromatoporoids occurring in beds up to about 3 feet in thickness and occasionally scattered throughout. Bryozoans and some brachiopods are also present. These beds represent deposition in tidal channel, intertidal, and some supratidal environments and represent a regressive phase within the general transgression of this time period.

7) New Creek Limestone and the contact with the underlying Keyser Limestone - The New Creek is a thick-bedded generally coarse to very coarse grained limestone (dominantly biosparites and biosparudites) containing abundant crinoid and brachiopod skeletal debris. It represents a sub-tidal wave-influenced environment which shows regional variations in characteristics. This contrasts to the immediately underlying intertidal and supratidal Keyser (Byers Island) facies over which the New Creek environment transgressed. This produced a distinct erosional contact often with several inches of relief and Keyser clasts in the basal part of the New Creek. This contact is exposed in the north quarry wall but is more accessible at point 7. It is an interesting example of normal carbonate facies relationships which in the past have often been interpreted as more significant regional unconformities.

8) Corriganville Limestone (proposed) - Thin to medium bedded, fine to medium grained, very cherty limestones with an abundant brachiopod fauna. Brachiopods tend to be more biplanate and have wider hinge lines than in the underlying higher-energy New Creek facies. This and the generally finer grain size suggest a quieter, less-agitated, more offshore environment. A shallow shelf area just offshore of New Creek type environments seems likely. Good specimens of silicified brachiopods are found in this unit. This is the "New Scotland Limestone" of many previous authors.

9) Mandata Shale - A blocky to platy weathering mudstone and shale with occasional lenses and thin beds of calcarenite towards the base. A variety of brachiopods is found towards the base and phosphate nodules are common there also. A wide variety of burrows occur in this facies. This unit appears to have been deposited predominantly in the median portion of the basin, seaward of the Corriganville and New Creek facies.

10) Shriver Chert - Dark gray to black, buff and tan weathering extremely cherty silty argillites and calcareous siltstones. The sparse epifaunal remains coupled with the number of burrows and the thoroughness of organic reworking suggest that this environment existed in deeper water in the central part of the basin and was characterized by a soft substrate. Stratigraphic relationships support this concept.

11) Oriskany Sandstone - Massively bedded medium to coarse grained calcareous quartz sandstone and sandy limestone. The transitional nature of the upper very calcareous Shriver and the overlying Oriskany is well displayed here and suggests that in this area the two environments may have been transitional.

Depart the Corriganville Quarry and proceed west on Maryland Route 36.

194.8 Mount Savage

200.5 Frostburg, Maryland

BIBLIOGRAPHY

Berg, Thomas M., McInerney, Michael K., Way, John H., and MacLachlan, David B., (1983), Stratigraphic Correlation Chart of Pennsylvania: Pennsylvania Geol. Survey, 4th ser., General Geology Report 75.

Busanus, James W., (1974), Paleontology and Paleoecology of the Mauch Chunk Group in Northwestern West Virginia, Bowling Green State University, Bowling Green, Ohio, unpub. M.S. thesis, 330 p.

Dennison, John M., et al., (1972), Stratigraphy, Sedimentology, and Structure of Silurian and Devonian Rocks Along the Allegheny Front in Bedford County Pennsylvania, Allegheny County Maryland and Mineral and Grant Counties, West Virginia, Guidebook, 37th Annual Field Conference of Pennsylvania Geologists, Bureau of Topographic and Geologic Survey, Department of Environmental Resources, Harrisburg, 114 p.

Duncan, Helen, (1969), Bryozoans: Geol. Soc. Am., Mem. 114, p. 345-433.

Edmunds, W. E., Berg, T. M., Sevon, W. D., Piotrowski, R. C., Heyman, L., and Rickard, L. V., (1979), The Mississippian and Pennsylvanian (Carboniferous) Systems in the United States -- Pennsylvania and New York: United States Geological Survey Professional Paper 1110, B1-B33.

Flint, N. K., (1965), Geology and Mineral Resources of Southern Somerset County, Pennsylvania: Pennsylvania Geol. Survey, 4th ser., County Report 56A, 267 p.

Haney, W. D., (1963), Stratigraphy of the Greenbrier Limestone in Pennsylvania: The Compass of Sigma Gamma Epsilon, v. 40, p. 191-204.

Hickok, W. O., and Moyer, F. T., (1940), Geology and Mineral Resources of Fayette County, Pennsylvania: Pennsylvania Geol. Survey, 4th ser., County Report 26, 530 p.

Horowitz, Alan S., and Rexroad, Carl B., (1972), Conodont Biostratigraphy of Some United States Mississippian Sites: J. Paleontol., v. 46, no. 6, p. 884-891.

Hoskins, Donald M., (1961), Stratigraphy and Paleontology of the Bloomsburg Formation of Pennsylvania and Adjacent States: Pennsylvania Geol. Survey, 4th ser., Bull. G. 36, 124 p.

________, (1972), The Silurian Williamsport Sandstone From Southern Bedford County, Pennsylvania to Keyser, West Virginia, (in) Stratigraphy, Sedimentology, and Structure of Silurian and Devonian Rocks Along the Allegheny Front in Bedford County Pennsylvania, Allegheny County Maryland and Mineral and Grant Counties, West Virginia, p. 104-106.

Hoskins, Donald M., Inners, Jon D., and Harper, John A., (1983), Fossil Collecting in Pennsylvania: Pennsylvania Geol. Survey, 4th ser., General Geology Report 40, 215 p.

Kauffman, Erle G., and Scott, Robert W., (1976), Basic Concepts of Community Ecology and Paleoecology. In Structure and Classification of Paleo-communities: Dowden Hutchinson and Ross, Inc., Stroudsburg, Pa., p. 1-28.

McKinney, F. K., and Gault, H. W., (1980), Paleoenvironment of Late Mississippian Fenestrate Bryozoans, Eastern United States: Lethaia, v. 13, p. 127-146.

Meckel, L. D., (1970), Paleozoic Alluvial Deposition in the Central Appala-chians: a Summary, in Appalachian Geology: Central and Southern, Interscience Publishers, N. Y., p. 49-67.

Pettijohn, F. J., (1962), Paleocurrents and Paleogeography: Am. Assoc. Petr. Geol. Bull., v. 46, p. 1468-1493.

Rittenhouse, Gordon, (1949), Petrology and Paleogeography of Greenbrier Formation: Am. Assoc. Petrol. Geol. Bull., v. 33, p. 1704-1730.

Rudwick, M. J. S., (1970), Living and Fossil Brachiopods: Hutchinson University Library, London, 199p.

Shaffner, Marchant N., (1963), Geology and Mineral Resources of the Donegal Quadrangle, Pennsylvania: Pennsylvania Geol. Survey, 4th ser., Atlas 48, 119 p.

Simonsen, August H., and Cuffey, Roger J., (1980), Fenestrate, Pinnate, Ctenostome Bryozoans and Associated Barnacle Borings in the Wreford Megacyclothem (Lower Permian) of Kansas, Oklahoma, and Nebraska: The University of Kansas Paleontological Contributions paper 101, p. 1-38.

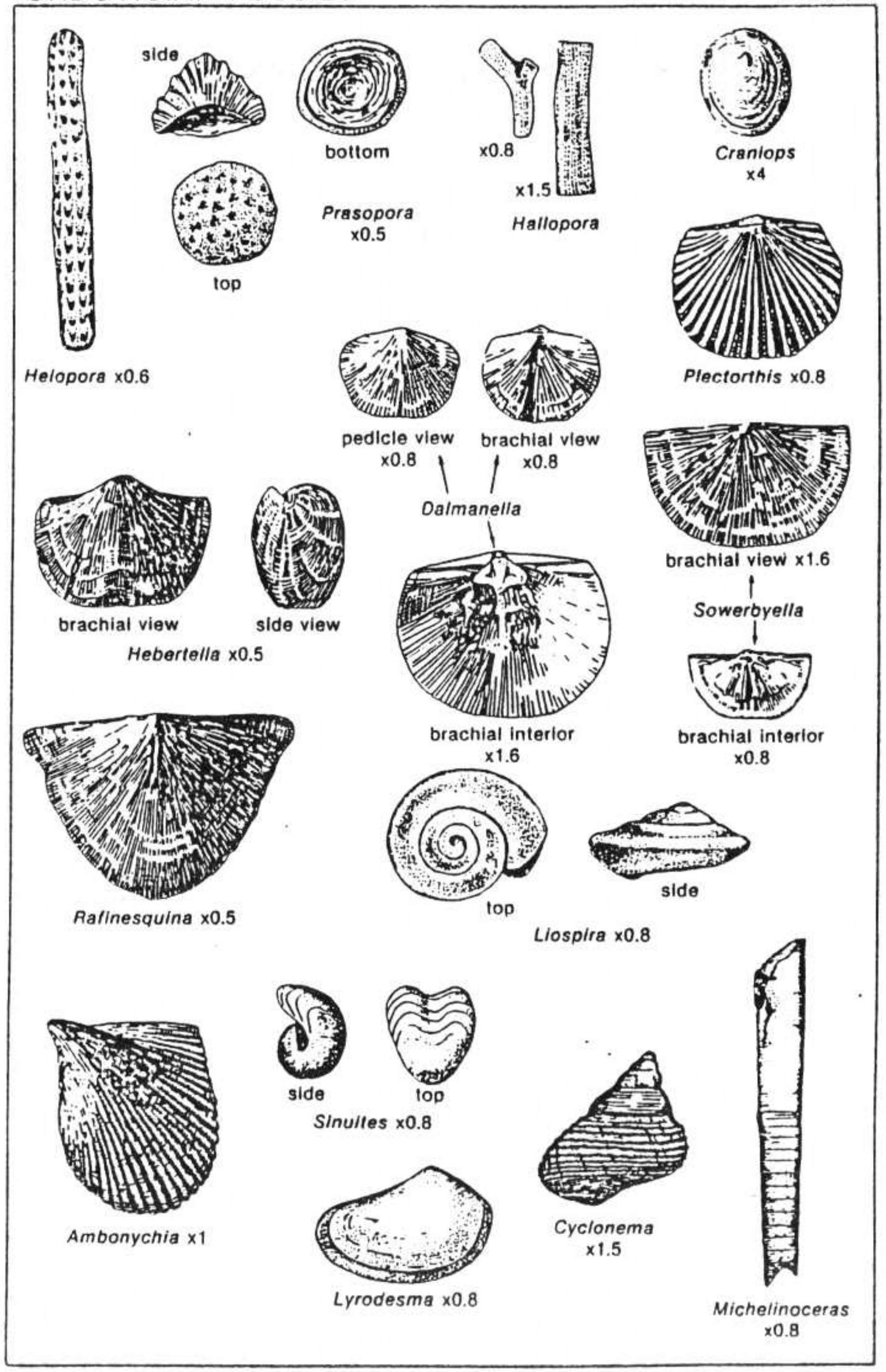
Simonsen, August H., (1985), Bryozoans from the Upper Mississippian Wymps Gap Limestone: X International Congress of Carboniferous Stratigraphy and Geology, Compte Rendu, pp. 351-362.

Tasch, Paul, (1980), Paleobiology of the Invertebrates -- Data Retrieval from the Fossil Record, John Wiley & Sons, N. Y., 2nd Ed., 975 p.

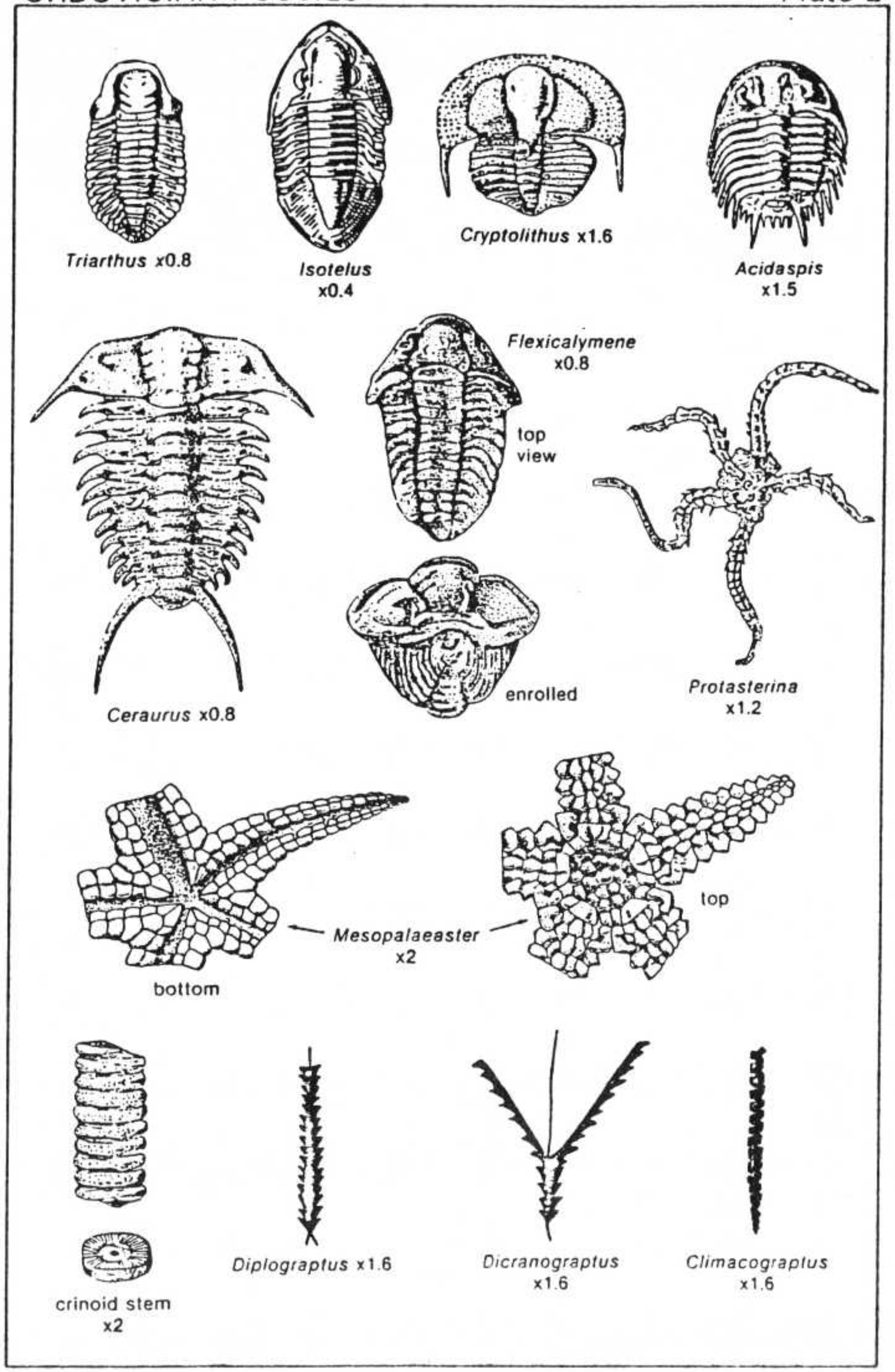
Wilson, James Lee, (1975), Carbonate Facies in Geologic History, Springer-Verlag, Berlin, 471 p.

The following fossil illustrations were reprinted from FOSSIL COLLECTING IN PENNSYLVANIA, Pennsylvania Geological Survey, 4th Series, General Geology Report 40 (1983). Appreciation is expressed to the Pennsylvania Geological Survey for granting us permission to reprint these plates.

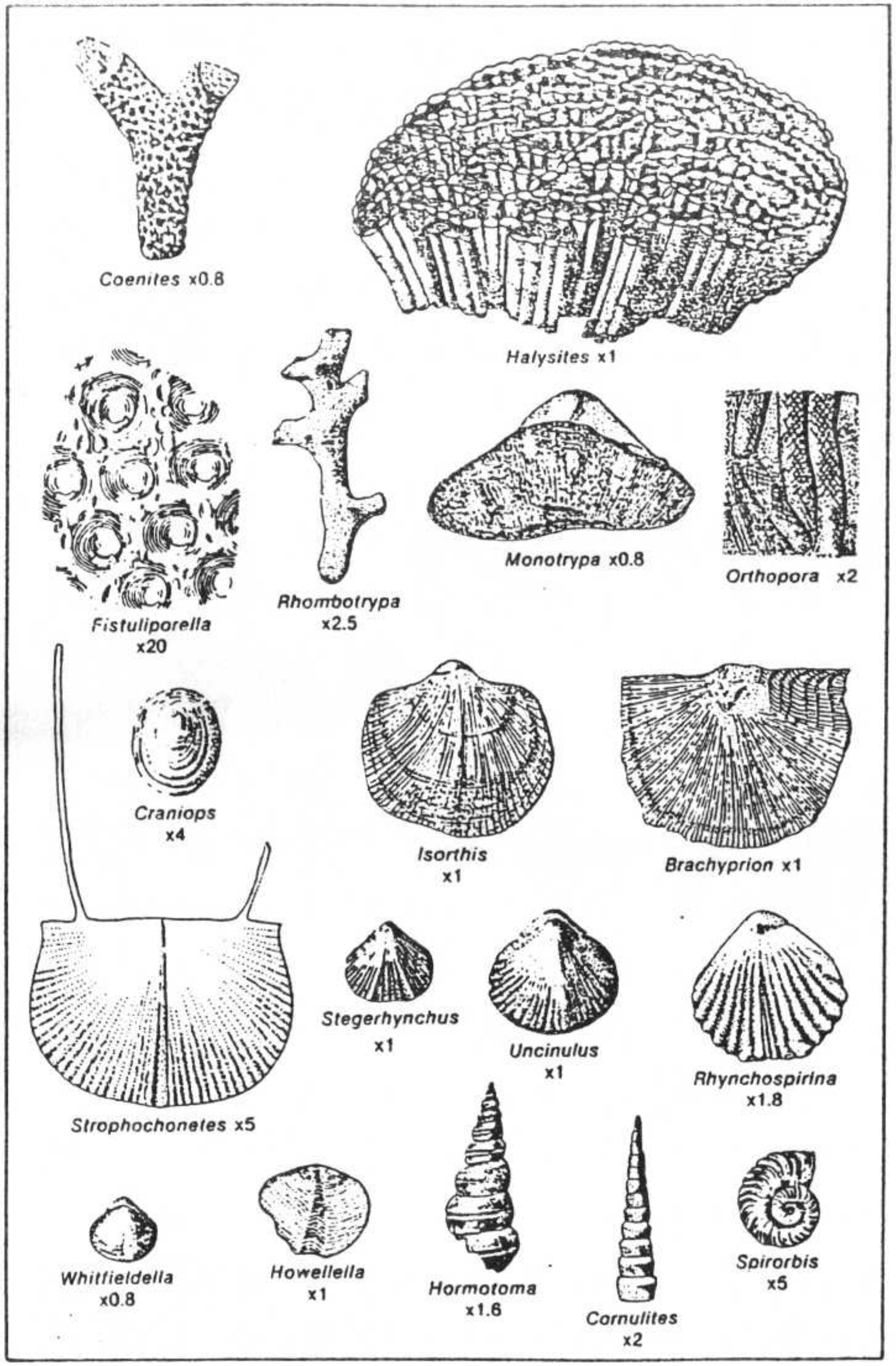
ORDOVICIAN FOSSILS Plate 1



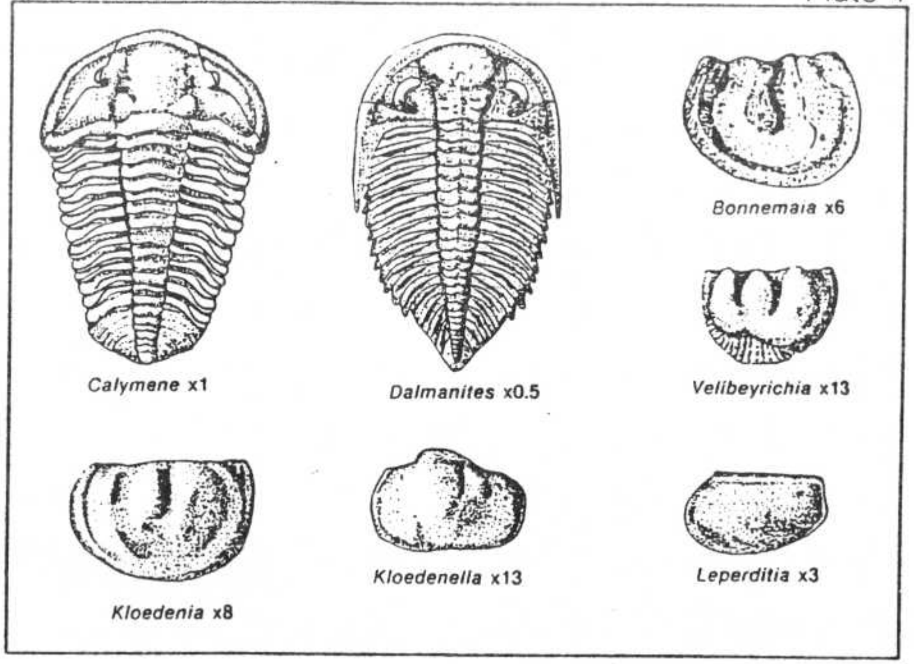
ORDOVICIAN FOSSILS Plate 2



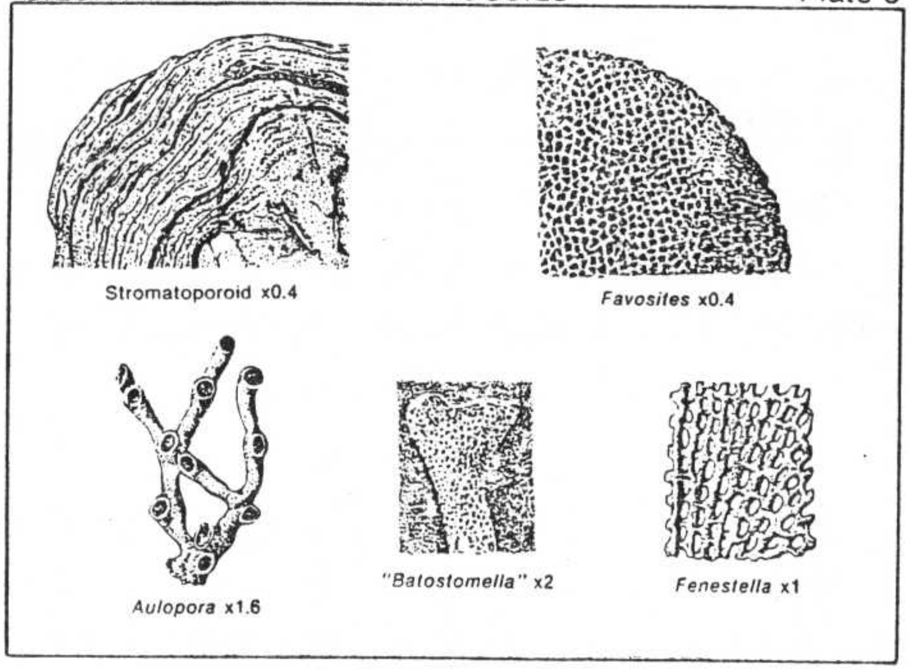
SILURIAN FOSSILS — Plate 3



SILURIAN FOSSILS — Plate 4

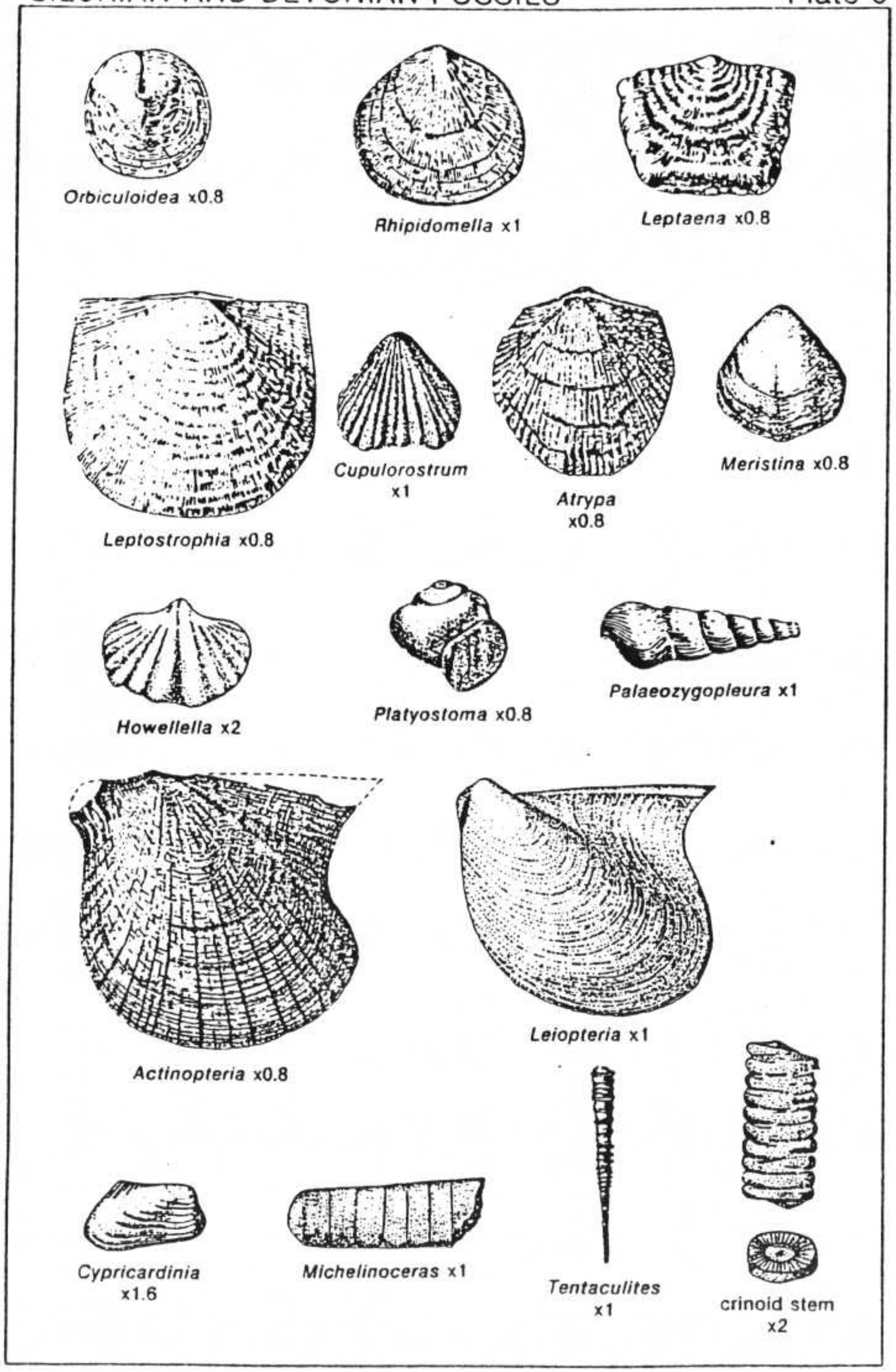


SILURIAN AND DEVONIAN FOSSILS — Plate 5



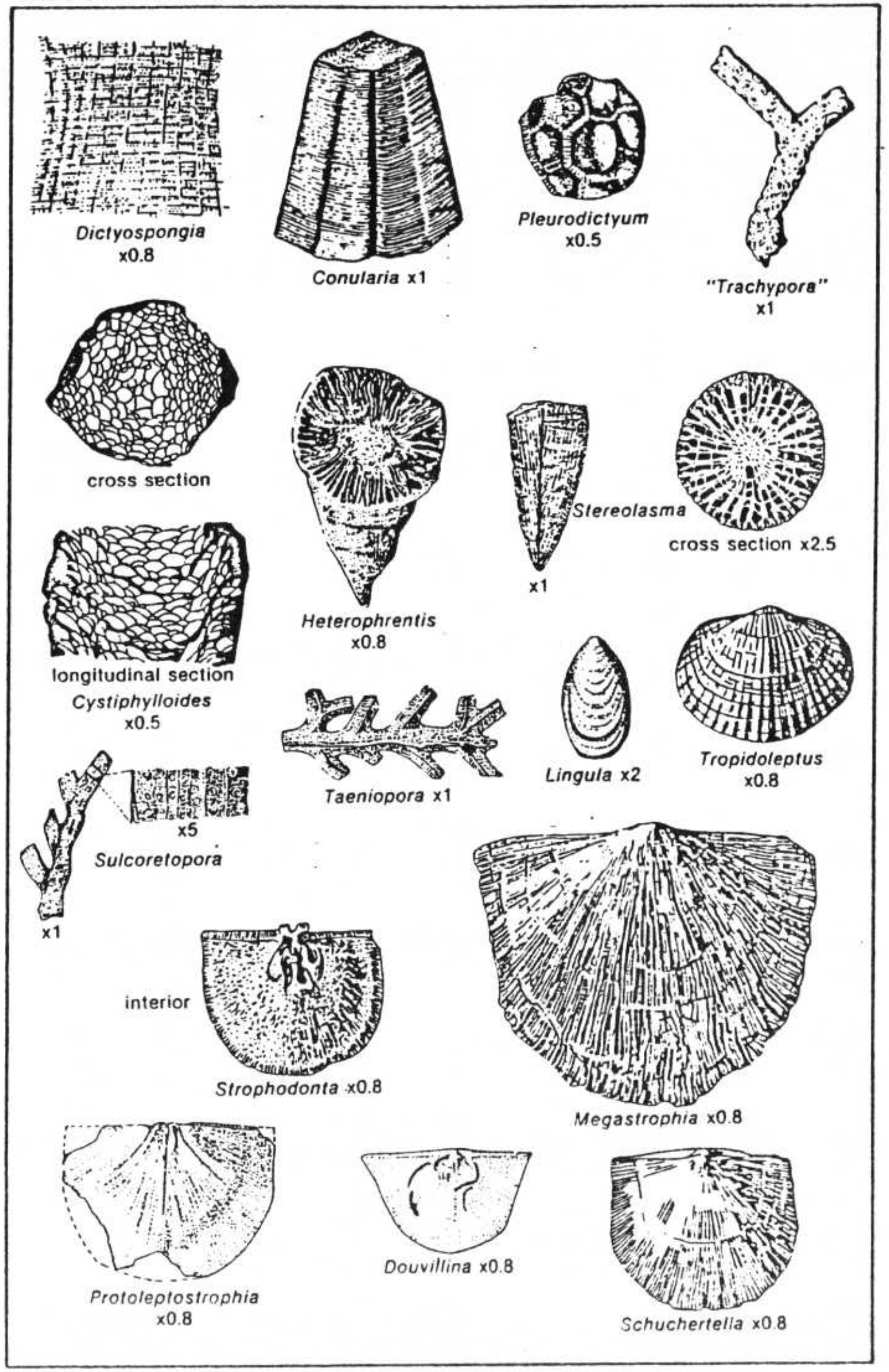
SILURIAN AND DEVONIAN FOSSILS

Plate 6



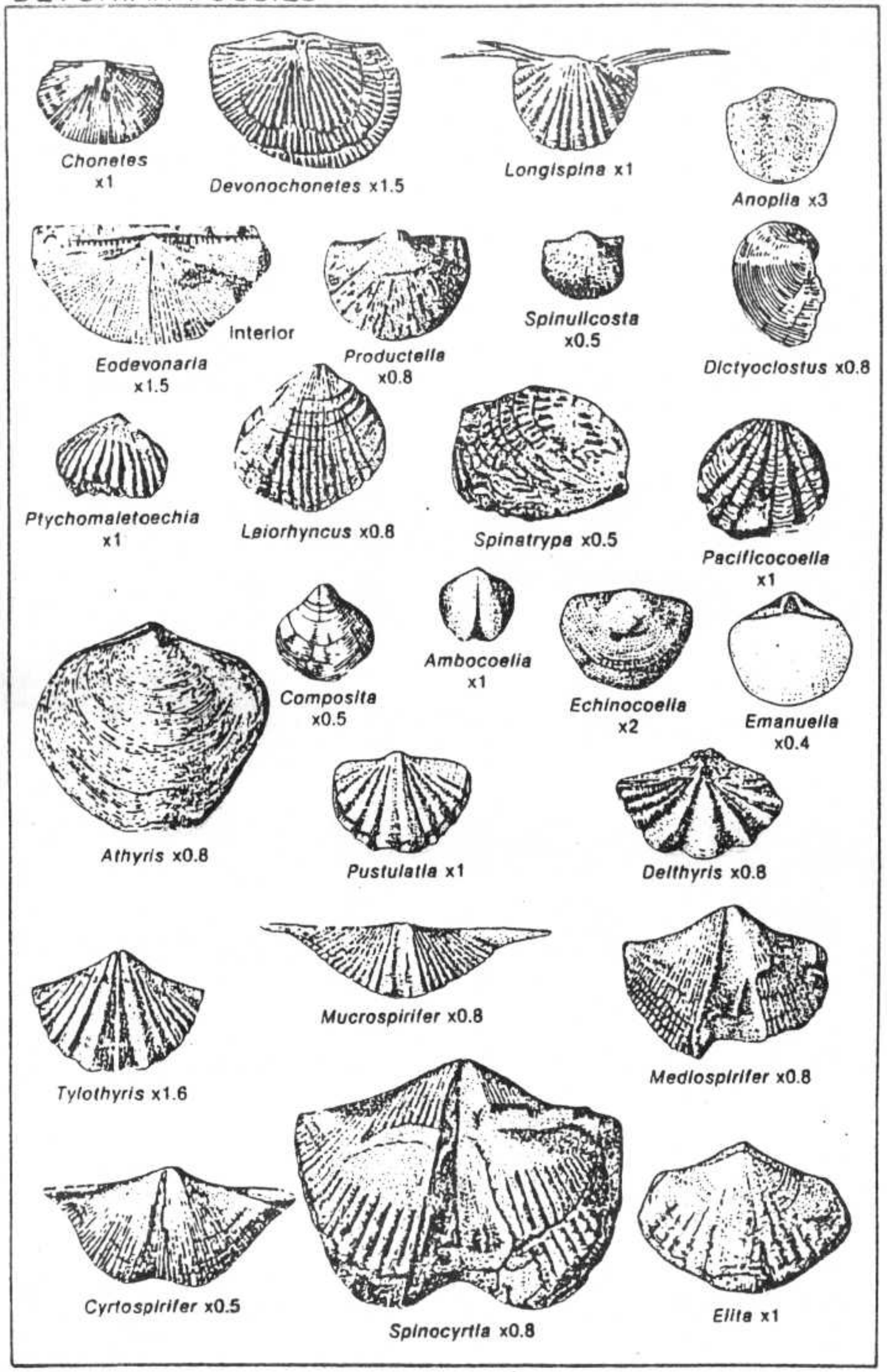
DEVONIAN FOSSILS

Plate 7



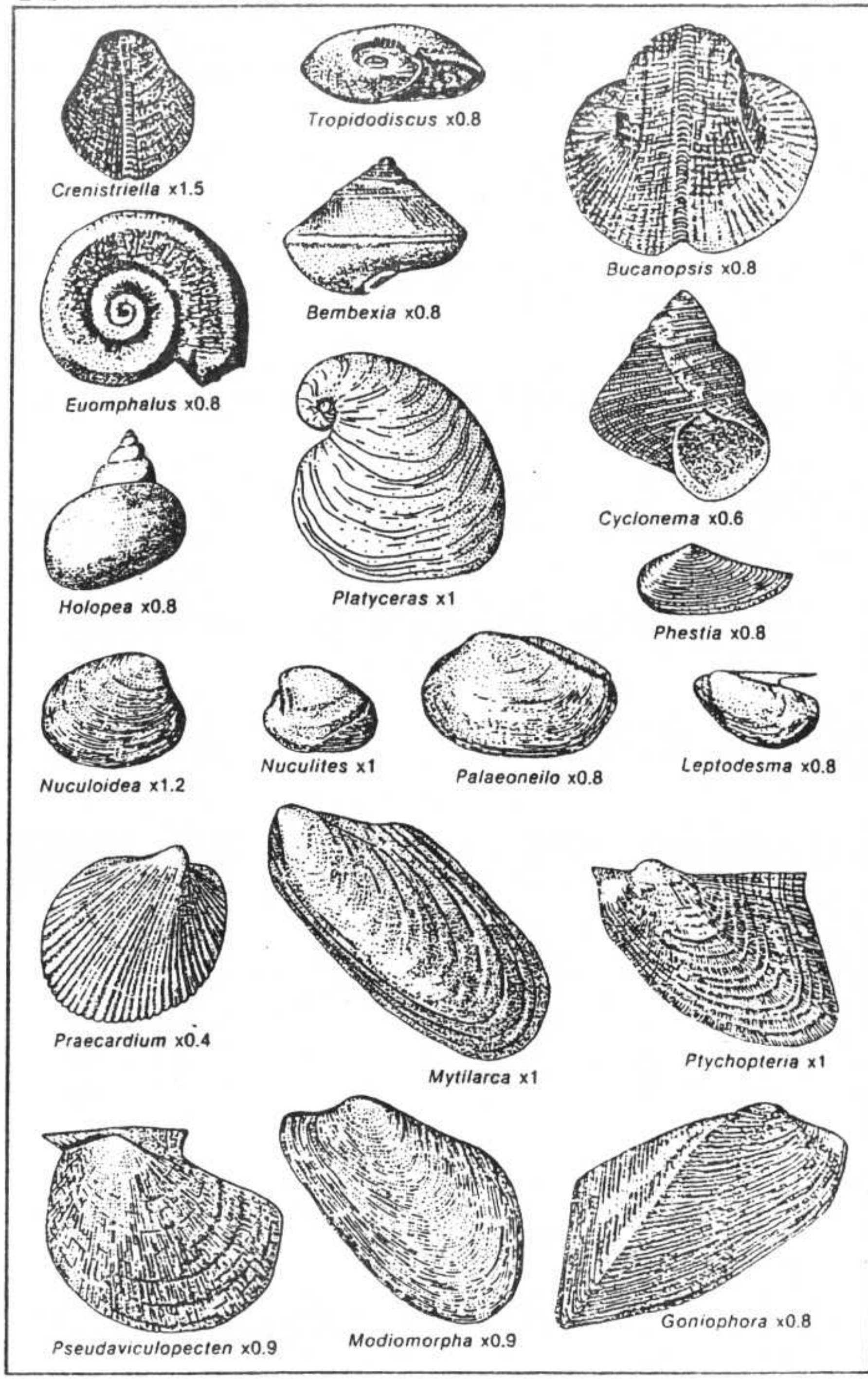
DEVONIAN FOSSILS

Plate 8



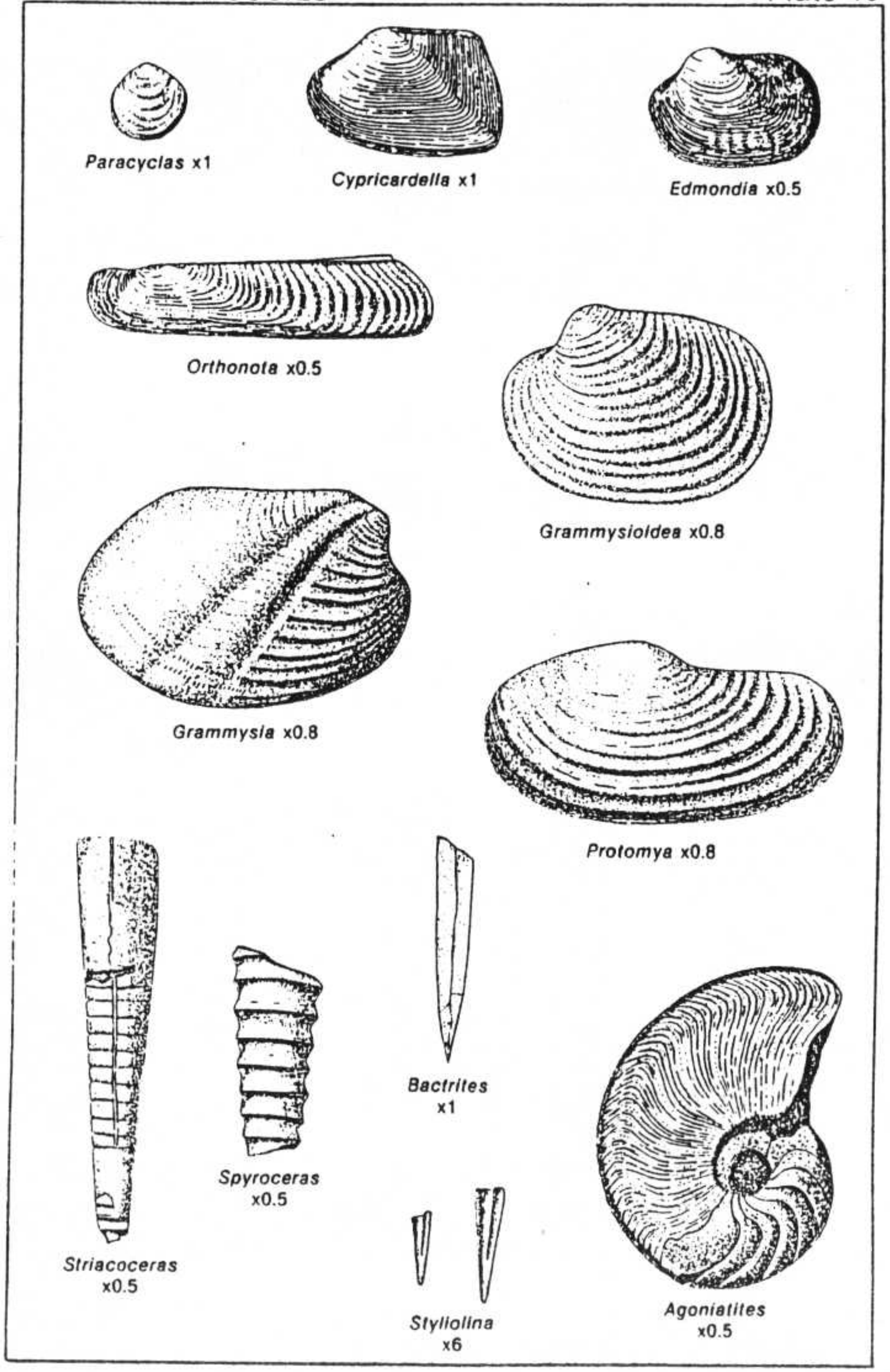
DEVONIAN FOSSILS

Plate 9



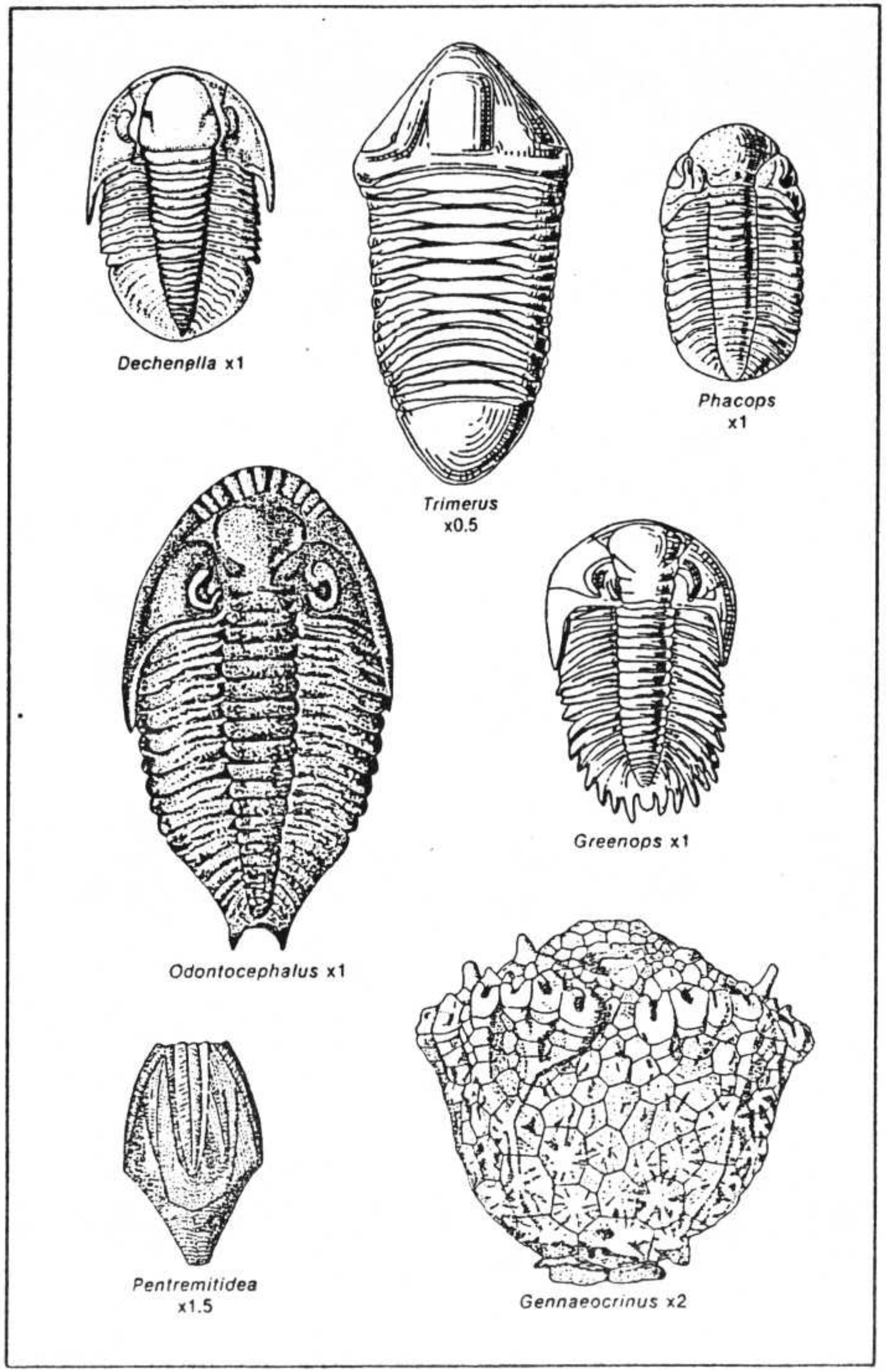
DEVONIAN FOSSILS

Plate 10

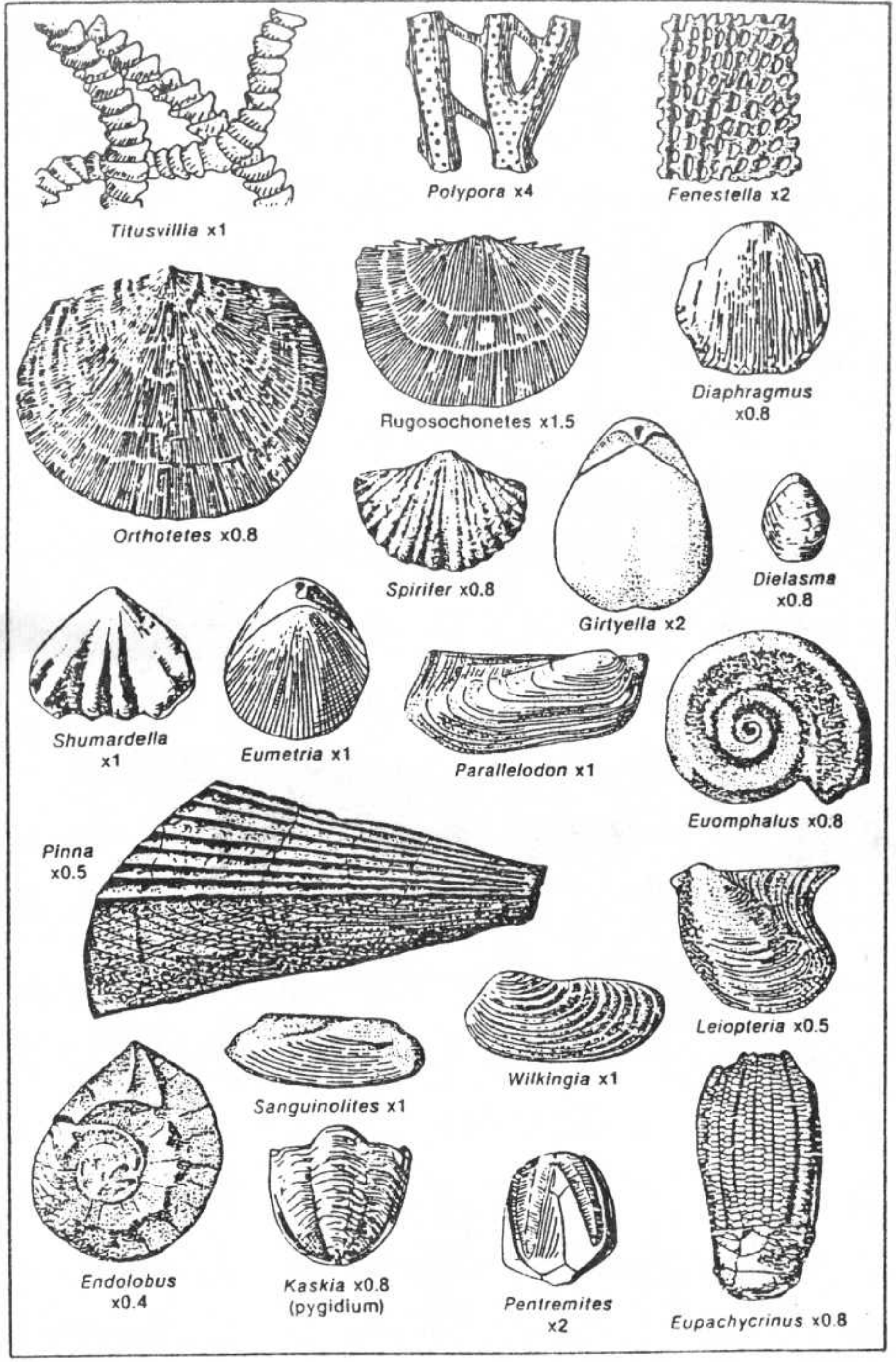


DEVONIAN FOSSILS

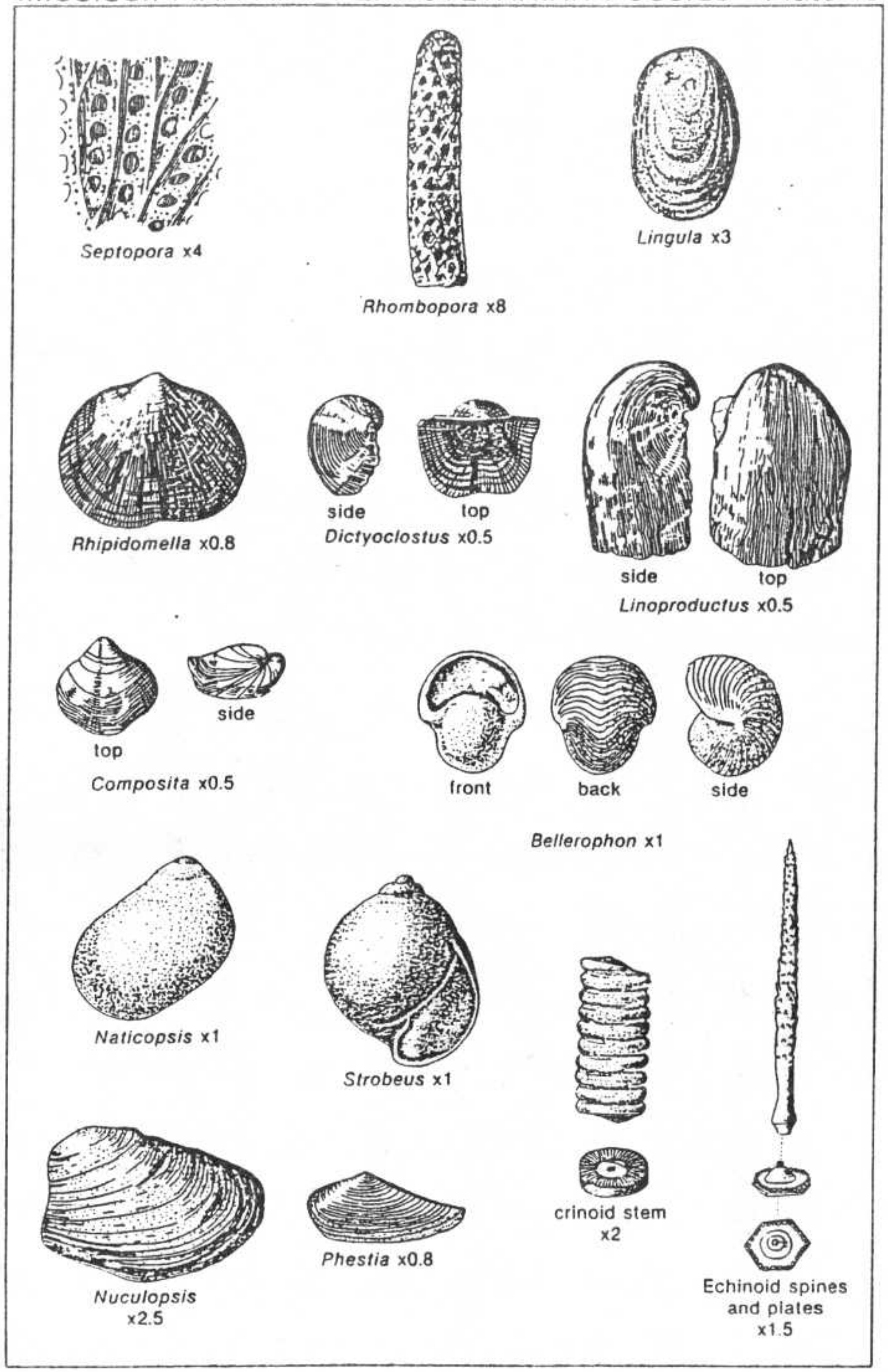
Plate 11



MISSISSIPPIAN FOSSILS Plate 12

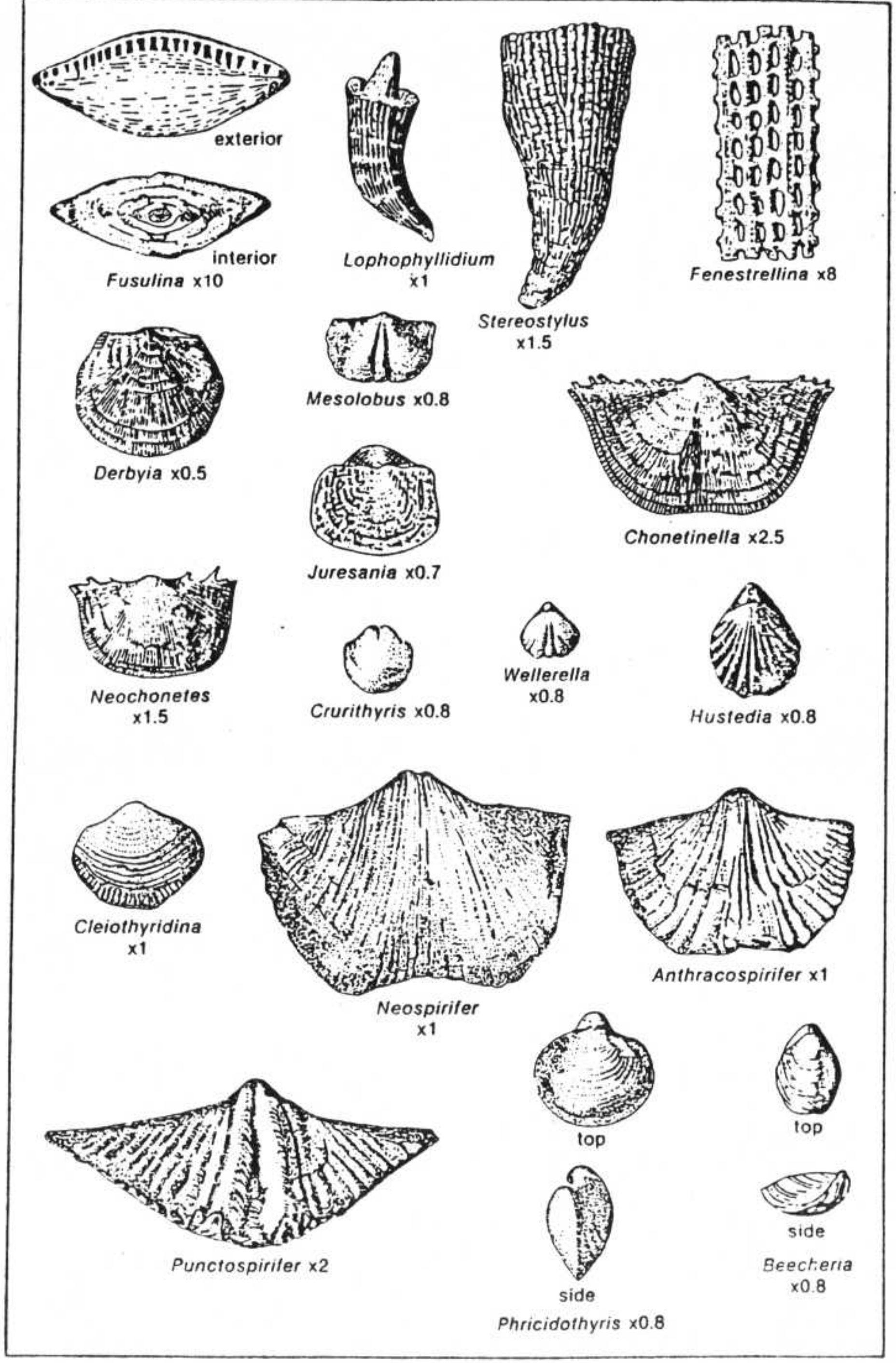


MISSISSIPPIAN AND PENNSYLVANIAN FOSSILS Plate 13



PENNSYLVANIAN FOSSILS

Plate 14



PENNSYLVANIAN FOSSILS

Plate 15